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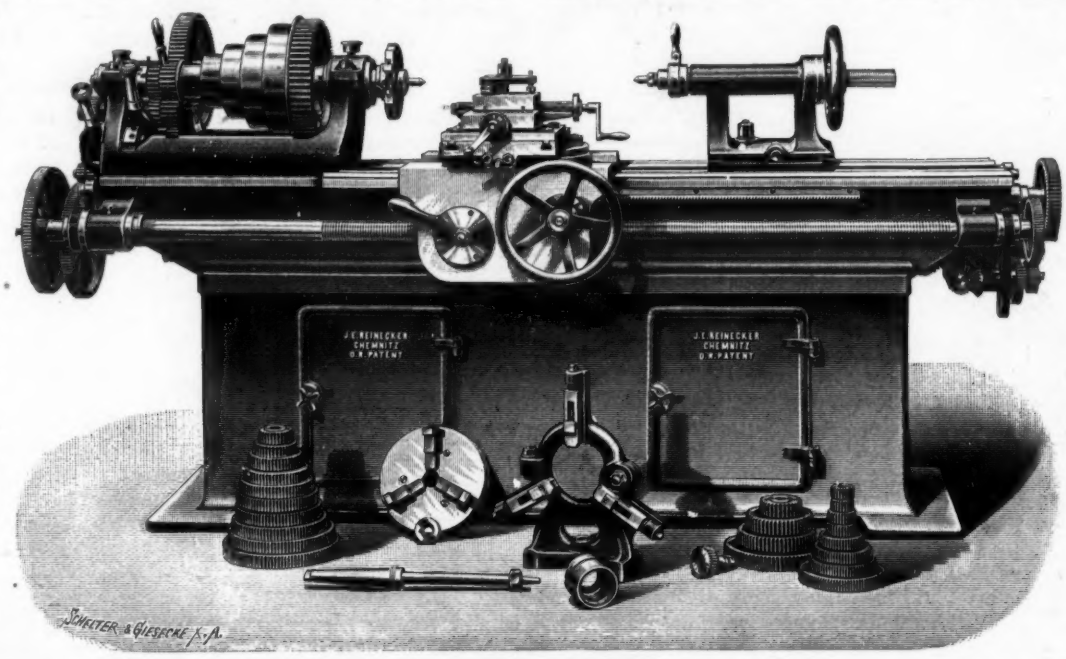
A Universal Relieving Lathe.

It will be remembered that in our account of the machinery shown at Chicago in 1893 we illustrated a lathe which was part of the exhibit of J. E. Reinecker, Chemnitz-Gablenz, Germany, and was designed especially for backing-off or relieving milling cutters of any form with teeth either straight or spiral. This lathe and the work done by it was one of the prominent features of the machinery exhibit, and it will be remembered that some features of it could not at that time be described, and the possible arrangement of mechanisms to perform one of its functions has since been made one of Mr. Allen's problems, and has called out some interesting solutions.

We are now able to give full particulars regarding—not the same individual machine, but a lathe embodying the same principles and improved in its arrangements and details.

A general view of the lathe is given on this page by which it is seen to be much like other modern engine lathes, embodying many features of what is considered here to be the best and most advanced practice. The lathe is, in fact, adapted to regular work, its special features not interfering in the least with such use of it.

At Figs. 2 and 3 are a side and end elevation of the lathe, and at Figs. 4, 5, 6 and 7 some sections by which its special features will be readily understood.



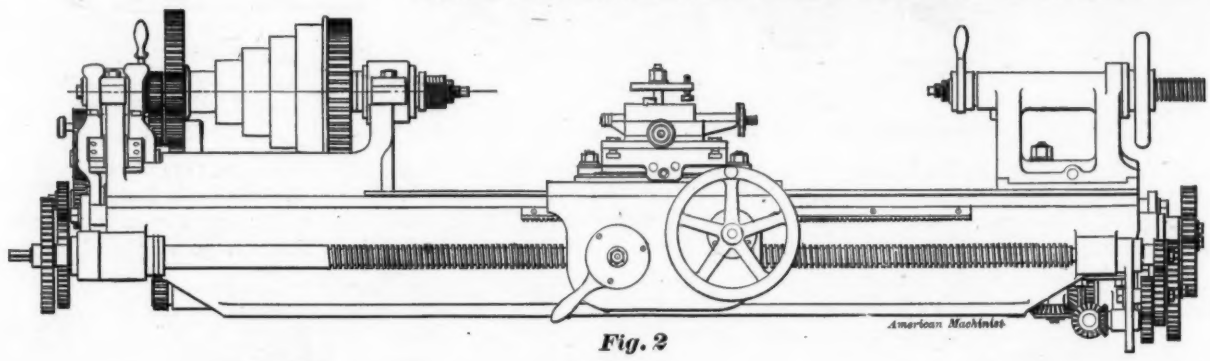


Fig. 2

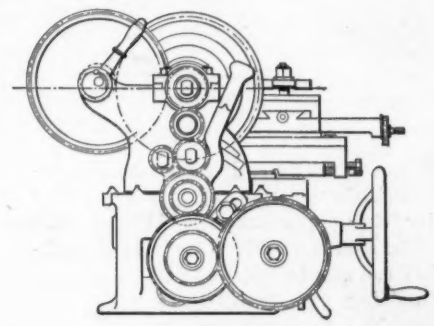
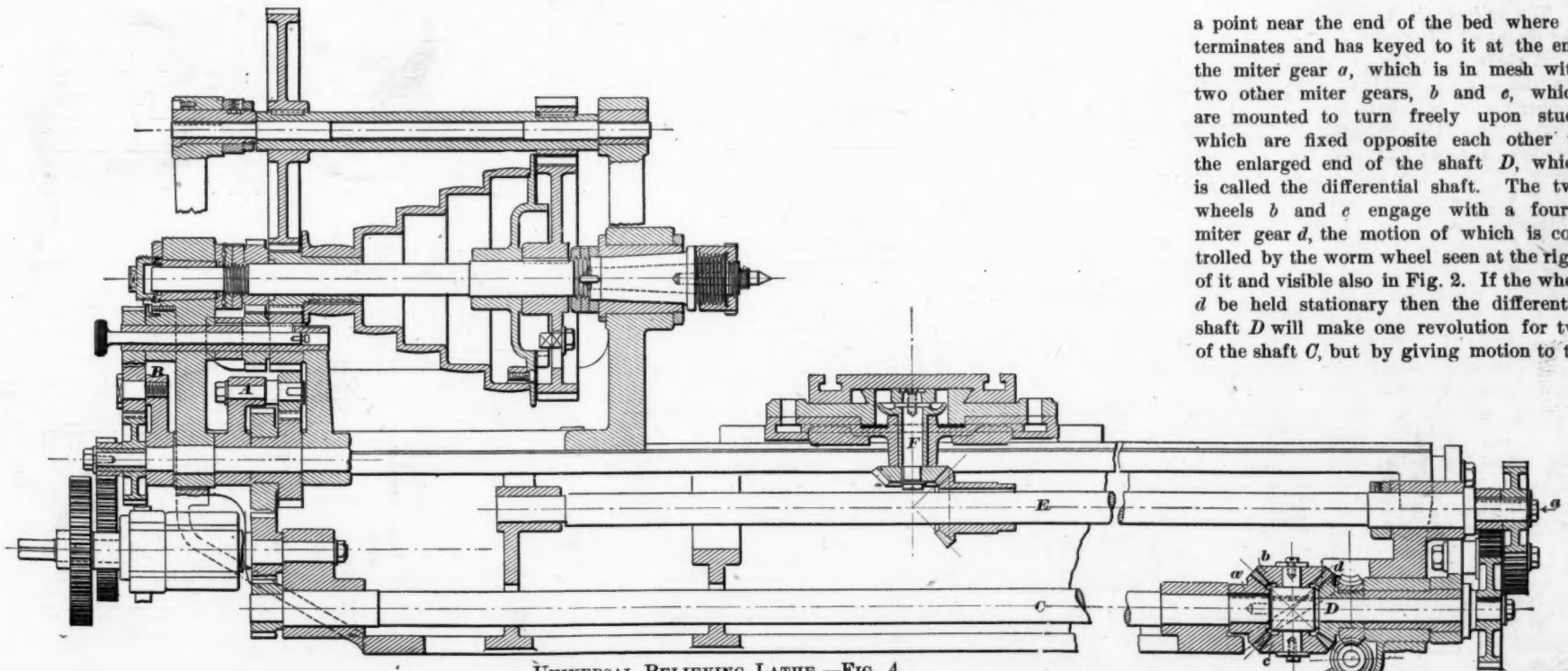


Fig. 3



UNIVERSAL RELIEVING LATHE.—FIG. 4.

Referring to Fig. 4 the arrangement of spindle bearings is seen, the front bearing being taper, and the thrust taken upon a ring of steel balls at the forward end of the rear bearing. Just below this bearing is a stud shaft, which is fitted with a sliding key moved by the knurled knob outside, by means of which this stud can be driven by either one of two gears which are mounted loosely upon it near its inner end. These gears are the same size, and one of them engages with a gear keyed to the main spindle, while the other engages with the gear on the cone pulley. Since the ratio of the back gearing is 16 to 1, it is evident that when the back gear is thrown in threads of two different pitches can be cut by using the same arrangement of change gears, the pitch of thread cut when the key is pushed in being 16 times as great as when the key is pulled out. The drive from the cone pulley is especially useful when cutting worms or other very coarse threads. Outside the head and below this stud is placed the usual tumbling gear arrangement by which the motion is reversed, so that right or left-hand threads may be cut, and translating gears are supplied by which metric threads or model threads having 3.1416 mm. as a unit of measurement may be cut.

The previously mentioned gear, driven from the cone pulley, acts also as an idler by means of which a train of gearing is driven that gives motion to the shaft *C* which passes through the bed as shown to a point near the end of the bed where it terminates and has keyed to it at the end the miter gear *a*, which is in mesh with two other miter gears, *b* and *c*, which are mounted to turn freely upon studs which are fixed opposite each other in the enlarged end of the shaft *D*, which is called the differential shaft. The two wheels *b* and *c* engage with a fourth miter gear *d*, the motion of which is controlled by the worm wheel seen at the right of it and visible also in Fig. 2. If the wheel *d* be held stationary then the differential shaft *D* will make one revolution for two of the shaft *C*, but by giving motion to the gear *d* by means of the worm gearing driven from a train of change gears attached to the

end of the lead screw as shown at Figs. 2 and 7, the motion of the differential shaft *D* and of the splined shaft *E* can be modified; the last-named shaft being driven by the differential shaft through the medium of another train of change gears as shown in Figs. 2, 4 and 5. The motion of this entire train of mechanism can also be reversed by a tumbling gear arrangement under the head, controlled by the lever *A*, Fig. 4.

The splined shaft *E* drives by means of miter gears a vertical shaft *F*, which is fitted to the carriage, and at the upper end of which is a cam that gives a slide the required motion to cause the tool to back off or relieve the teeth of a milling cutter, and as this slide can be set at any desired angle as indicated in Fig. 8, it follows that the clearance can be given at any angle—including what is called side clearance if desired.

By means of changing the gears composing the last-named train, *i. e.*, the one connecting shafts *D* and *F*, the cam at the carriage can be given the required number of revolutions per revolution of the lathe spindle called for by the number of teeth in the cutter, and if these teeth are straight then this train of gears is the only one that needs to be considered, except that for giving the proper rate of feed, but if the teeth are spiral then a table shows the proper gears to use connecting the end of the lead screw with the worm shaft by means of which the miter gear *d* is given just the required motion to retard or accelerate the motion to compensate for the spiral, whether it be to the right or to the left.

When the cutter to be relieved is of irregular outline the device, Fig. 9, is used, where a form or pattern *a* is adjustably secured to a bar which is supported by brackets attached to the back of the lathe bed by a T-slot.

It will be noticed in Fig. 8 that the slides of the compound rest can be kept in their normal position, if desired, regardless of the angle to which the backing-off slide is set, and that they can be moved in or out upon the lower to suit circumstances.

The lathe not only produces milling cutters which can be ground on the faces of the teeth with change of form, but it will also give clearance to worm hobs and do a large variety of similar work not within the scope of the ordinary lathe, nor indeed of any other single machine, so far as we are aware.

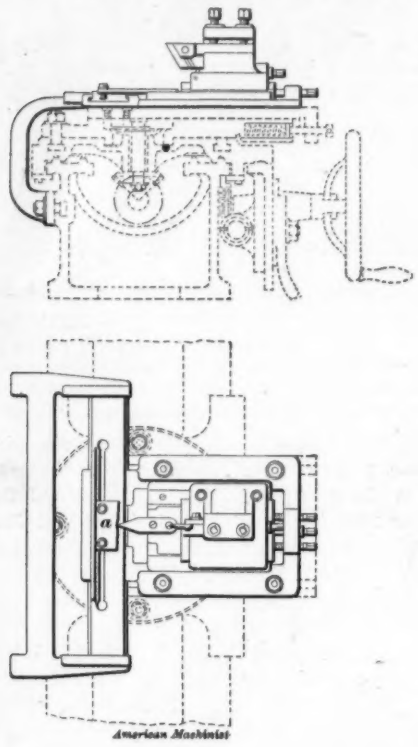


Fig. 9

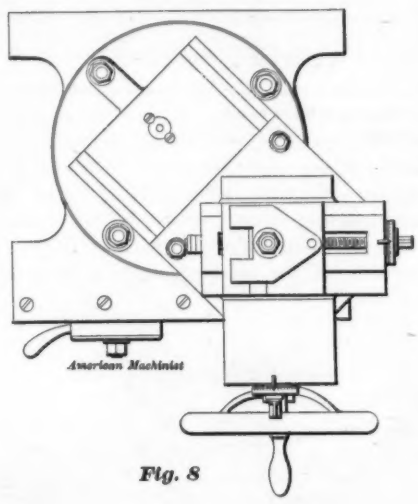


Fig. 8

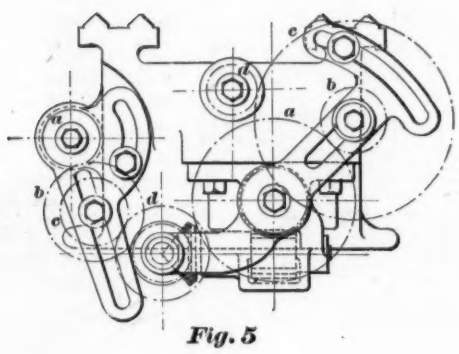


Fig. 5

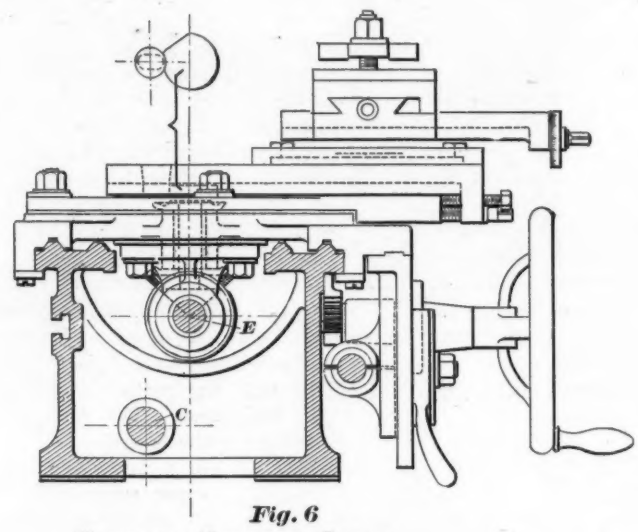


Fig. 6

Universal Relieving Lathe.

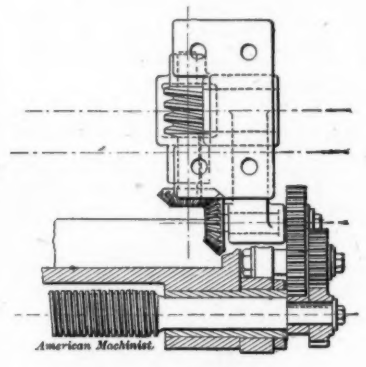


Fig. 7

Express Locomotives.

The diagrams of a number of types of express locomotives, used in different countries, compiled by John A. F. Aspinall, Chief Mechanical Engineer Lancashire & Yorkshire Railway, and published in *The Engineer*, London, are of considerable interest. From these we have selected some of the principal types, and taken extracts from the descriptive matter, believing they will be of interest to railroad men in this country.

The Great Eastern Railway Company use a type of engine, shown in Fig. 7, which has four wheels coupled. The leading end of this engine is carried by a pair of wheels, which have four journals, the outer pair taking the principal portion of the weight, while the inner are devoid of collars. The cylinders are fixed inside the frames with the valves underneath, which arrangement effectively drains the cylinder from condensed steam, and also allows the valves to fall from their faces when running with the regulator closed. The valve motion is of the Stephenson type, the balancing of which is effected by means of a spring. The average speed attained by the engines is 45.2 miles per hour, for 55.75 miles with a coal consumption 33.9 pounds per train mile, and a net load of 196 tons. The gradients traversed by these engines are heavy, the curves sharp and numerous; the Westinghouse brake operates on the engine, tender, and train. The arrangement for the application of liquid fuel, and applied to several express engines on this line, has given very encouraging results. The blast-pipe orifice can be enlarged from 50 to 60 per cent, which reduces the wear and tear of the fire box and tubes, and also prevents the emission of sparks and ashes.

The London, Brighton & South Coast Railway Company's well-known engine of the Gladstone type, Fig. 8, was designed by the late Mr. Stroudley in 1881, and is still the type of engine used for fast traffic on the Brighton Line. There are many remarkable features about this engine, and it stands alone from the usual English practice. Although it is true that there are engines with their leading wheels coupled to the drivers on the Great Northern Railway, and that Mr. Adams has designed some for the London & South Western Line, the Gladstone class remains unique as regards so large a diameter as 6 feet 6 inches for the leading wheels coupled to the driving wheel. The trailing end is carried on a small pair of wheels 4 feet 6 inches diameter. The cylinders are placed inside the frames with the valves beneath, and actuated directly by the Stephenson link motion, the reversing of which is performed by a compressed air-reversing gear. It may be observed that the outside cranks are placed upon the same side of the axle as the inside cranks, instead of upon the opposite, as is the usual practice. The average weight of trains hauled

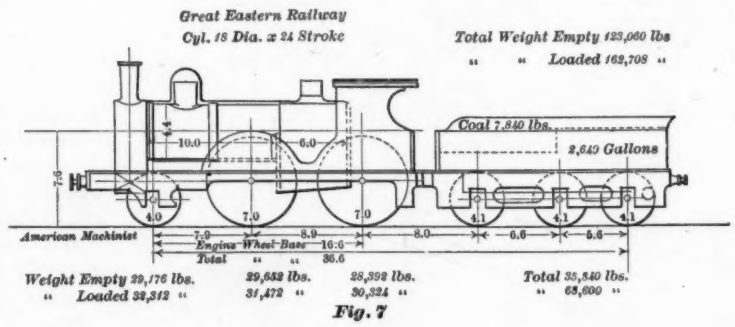

Great Eastern Railway
Cyl. 18 Dia. x 24 Stroke
Total Weight Empty 123,060 lbs
" " Loaded 162,708 "
Coal 7,840 lbs.
2,643 Gallons
American Machinist
Engine Wheel Base 16:6
Total " " 36:6
Weight Empty 29,176 lbs. 29,652 lbs. 28,392 lbs. Total 35,840 lbs.
" Loaded 38,312 " 31,472 " 30,324 " " 65,600 "

Fig. 7

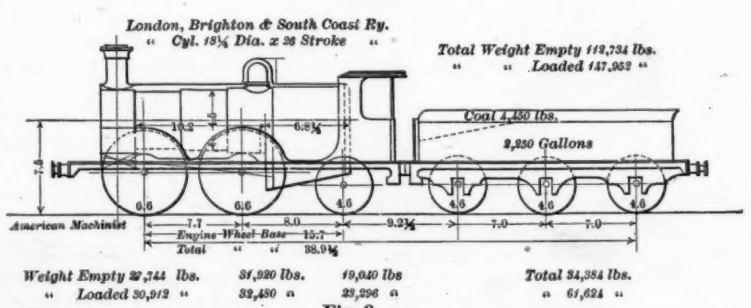

London, Brighton & South Coast Ry.
" Cyl. 18¼ Dia. x 26 Stroke "
Total Weight Empty 112,734 lbs.
" " Loaded 147,952 "
Coal 4,480 lbs.
2,250 Gallons
American Machinist
Engine Wheel Base 15:7
Total " " 35:9½
Weight Empty 27,344 lbs. 31,920 lbs. 19,040 lbs Total 34,384 lbs.
" Loaded 30,912 " 32,480 " 23,296 " " 61,624 "

Fig. 8

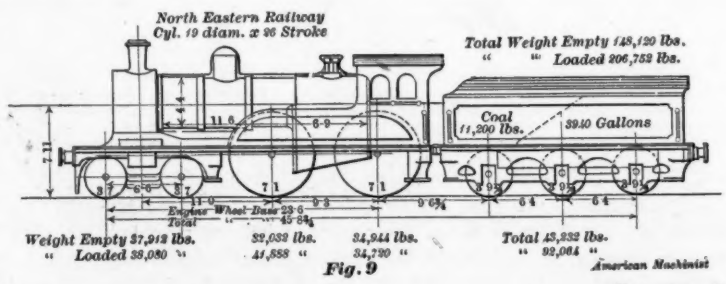

North Eastern Railway
Cyl. 19 diam. x 26 Stroke
Total Weight Empty 148,120 lbs.
" " Loaded 206,752 lbs.
Coal 11,200 lbs.
3940 Gallons
American Machinist
Engine Wheel Base 23:6
Total " " 45:2½
Weight Empty 37,912 lbs. 32,032 lbs. 34,944 lbs. Total 43,232 lbs.
" Loaded 38,080 " 41,888 " 34,720 " " 92,064 "

Fig. 9

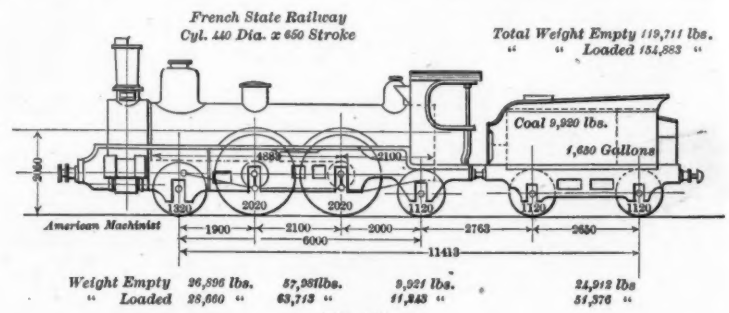

French State Railway
Cyl. 440 Dia. x 650 Stroke
Total Weight Empty 119,711 lbs.
" " Loaded 154,883 "
Coal 9,920 lbs.
1,630 Gallons
American Machinist
Weight Empty 26,896 lbs. 57,985lbs. 9,921 lbs. 24,912 lbs
" Loaded 28,660 " 63,713 " 11,243 " 51,276 "

Fig. 25

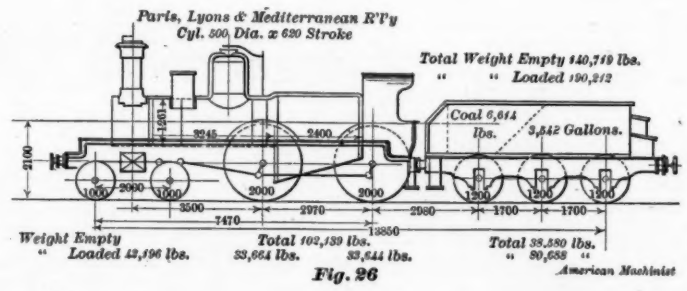

Paris, Lyons & Mediterranean R'Y
Cyl. 500 Dia. x 630 Stroke
Total Weight Empty 140,719 lbs.
" " Loaded 190,212
Coal 6,614 lbs.
3,542 Gallons.
American Machinist
Weight Empty Total 102,139 lbs. Total 38,580 lbs.
" Loaded 42,196 lbs. 33,664 lbs. 33,644 lbs. " 80,688 "

Fig. 26

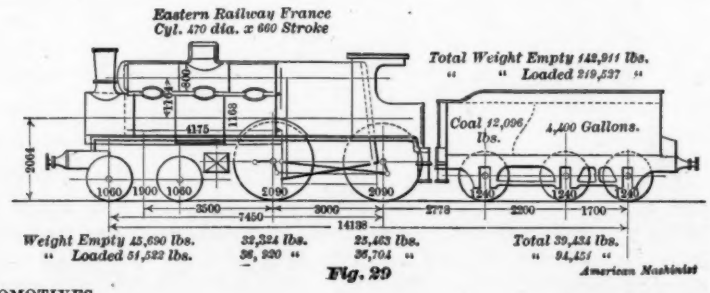

Eastern Railway France
Cyl. 470 dia. x 660 Stroke
Total Weight Empty 142,911 lbs.
" " Loaded 219,527 "
Coal 12,096 lbs.
4,400 Gallons.
American Machinist
Weight Empty 45,690 lbs. 32,324 lbs. 25,463 lbs. Total 39,434 lbs.
" Loaded 51,522 lbs. 36, 220 " 26,704 " " 94,451 "

Fig. 29

Express Locomotives.

by this class of engine is 269 tons net, at the high average speed of 43.3 miles per hour over heavy gradients; the Westinghouse automatic air brake is fitted throughout the train. The coal consumption is 30.93 pounds per train mile, and the boiler capacity is very large, with a total heating surface of 1,485.3 square feet.

The two types of engines, Figs. 9 and 55, are employed by the North Eastern Railway Company for working the fast Scotch dining cars between York and Edinburgh. Both engines are remarkable for their cylinder capacity, boiler power, and for the novel departure from the ordinary English practice, in placing the valve chests outside the frames, a method largely used on the continent. This arrangement became necessary by the use of cylinders 20 inches and 28 inches diameter for the compound (Fig. 55), and 19 inches diameter for the simple engine. The motion is of the Stephenson type, and connected to the valves by means of a rocking shaft. The crank axles of these engines are of special design, introduced by Mr. T. W. Worsdell when locomotive superintendent of the Great Eastern Railway. The webs are circular disks, which enable the thickness to be diminished proportionally with increased width, and also the crank can be finished entirely in the lathe. The fuel and water capacity of the tenders for these engines are very large, viz., 11,200 pounds of coal, 3,940 gallons, or nearly 18 tons, of water. Each engine is fitted with both the Westinghouse and automatic vacuum brakes. The engine, Fig. 9, is simple, but the other, Fig. 55, is compounded on the Worsdell and Von Borries system. The boiler pressure of the former is 160 pounds, and that of the latter 200 pounds per square inch. This system of compounding was first designed and introduced on the Great Eastern Railway by Mr. T. W. Worsdell, late engineer of the North Eastern Railway, and the latter company have upwards of 270 compounds at work, while there are at least 1,000 Worsdell and Von Borries engines working abroad. These two engines have been in competition on the North Eastern Railway, under the same conditions regarding loads and booked speeds, with the result that the compound shows a saving of 4.4 per train mile. The average speed of each engine was 47.75 miles per hour with a net load of 182 tons, and the consumption of coal was 32.8 pounds for the simple, and 28.4 pounds for the compound per train mile. The gradients traversed are heavy between Edinburgh and York, and the longest run without stops is 124.5 miles.

The State Railway of France employs the engine shown in Fig. 25, which is chiefly interesting for its valve gear, the main features being that the steam and exhaust ports are independent. The admission ports are at the top, and the exhaust at the bottom of the cylinder. This gear in some respects bears the same relation to the locomotive as the Corliss gear does to the stationary engine. The cylinders are 12 5/16 inches diameter by 25⅝ inches stroke, and are placed outside the frames in front of the leading wheels. The driving wheels are four coupled, 6 feet 7½ inches diameter, and are both placed in front of the fire box, which also distinguishes this engine from the ordinary practice. The leading and trailing ends are each supported on smaller wheels, 4 feet 4 inches, and 3 feet 8½ inches respectively. The tenders are small, carrying 4½ tons of fuel, and only 1,650 gallons of water. Briquette fuel is used, and the consumption is 26.9 pounds per mile, the average speed being 40.6 miles per hour, and the loads 138.9 tons net. This engine is fitted with the Wegner brake.

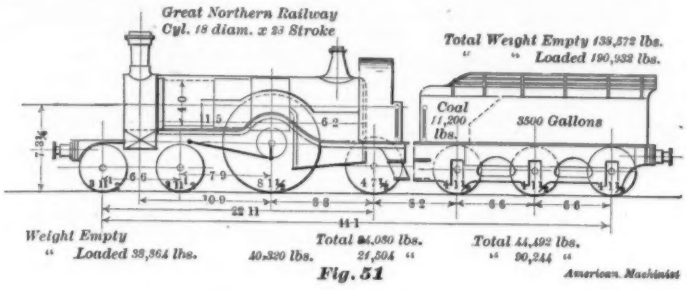


Fig. 54

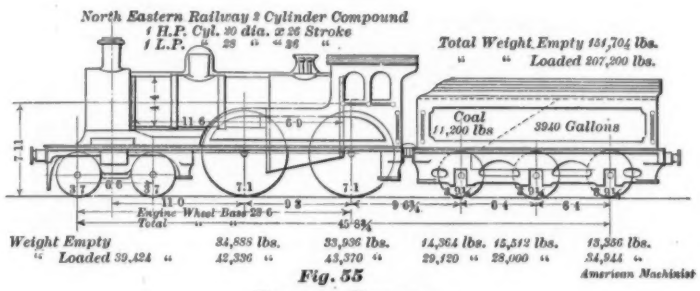
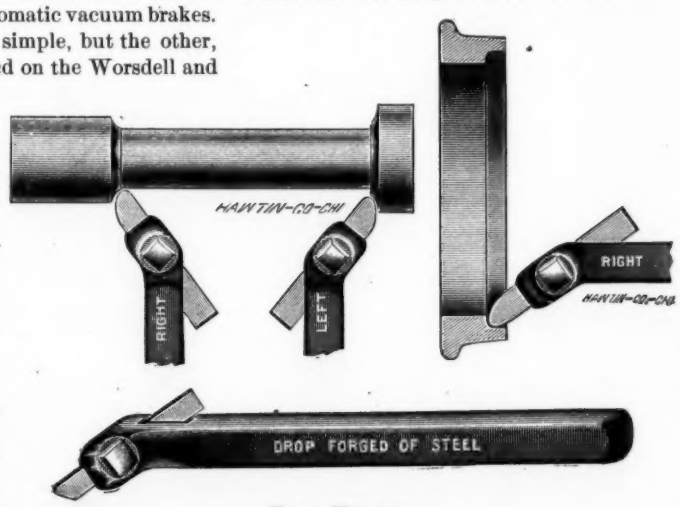


Fig. 55

EXPRESS ENGINES.

One of the types of engine used by the Paris, Lyons and Mediterranean Railway Company is shown by Fig. 26. It is a simple expansion engine of the outside-cylinder type with four wheels coupled and a leading bogie.

Fig. 29 shows the type of engine used for the express traffic of the Eastern Railway of France. Its most notable feature, the double boiler, records another departure in locomotive construction. It consists of two barrels, besides the fire box, the crown of the latter being constructed of corrugated steel, and arched. The top of this box is as high as the lower cylindrical part of the boiler, consequently the depth, as compared with the ordinary box, is very much increased, and therefore a greater space is gained for the combustion of furnace gases. The lower barrel is completely filled with 304 tubes, consequently the whole of this space can be filled with water, and therefore (with the volume of water at its normal level, *i. e.*, the center line of the upper barrel, which leaves a steam space of 63.25 cubic feet) the reserve power of this boiler is considerably increased. Three large openings are provided between the two barrels, besides the heating surface of the top of the fire box acting directly upon the water in the upper barrel, so that ample circulation is provided. The grate area is 26 square feet, and the heating surface amounts to 1,664.3 square feet for the tubes, and 146.44 square feet in the fire box. The cylinders are 19.68 inches by 25.98 inches, and mounted outside of frames near the center of the engine, with valves placed on top. The valve gear is of the Stephenson type, with outside eccentrics and ordinary reversing arrangements. The four driving wheels are coupled, 6 feet 10½ inches diameter, and the leading end is carried on a four-wheeled bogie. Steam sanding apparatus is used, and the engine is fitted with the Westinghouse brake. Trains of 201.5 tons net are hauled at an average rate of 42.5 miles per hour, over grades of 6 mm. per meter, with a fuel consumption of 41.7 pounds per mile, consisting of 80 per cent. slack and 20 per cent. briquette.



TOOL HOLDER.

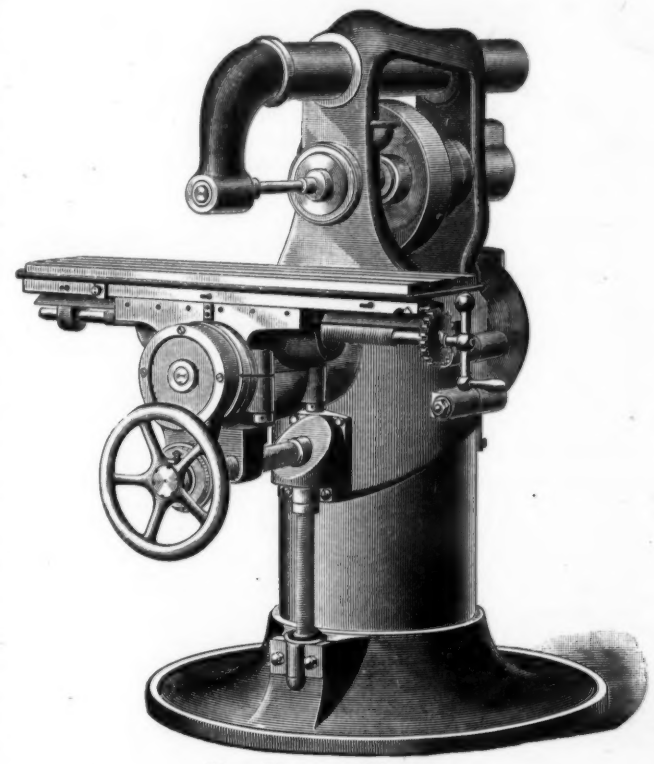
The Great Northern Railway Company are celebrated for their handsome outside cylinder single wheeled express engine, shown in Fig. 51. It was designed about twenty-six years ago by Mr. P. Stirling. The cylinders are 18 inches diameter and 28 inches stroke. The valves are placed inside the frames, and are driven by the ordinary type of link motion. On account of the great increase and weight to be hauled, Mr. Stirling has recently built a new class of single wheeled engines having cylinders 19½ by 28 inches, with a much greater heating surface and grate area. The driving wheels are 8 feet 1½ inches diameter, and are, as far as the author is aware, about the largest running on any railway excepting the old Cornwall on the London & North Western Railway, which has driving wheels 8 feet 6 inches diameter. It may be noticed that the bogie center pivot is not placed midway between the axles, but is 6 inches nearer the trailing axle, which gives an equitable distribution of weight on the wheels, and it is claimed that the engine passes round curves with greater freedom. The bogie is steadied by running pieces, bearing against brass slippers on the under side of the main frame. The absence of a dome necessitates the placing of the regulator in the smoke box, and the fixing of a Hawthorn collecting pipe inside the boiler. The East Coast route from London to Edinburgh is conducted by this company as far as York, a distance of 188 miles, and a great reputation for punctuality of its trains has been acquired, at the high average of speed in some of them of 55.6 miles per hour. This engine performs this duty on a coal consumption of 34 pounds per train mile, with average trains of 200 tons net. The longest run without stopping being 105 miles, causes the tender for this engine to be very large. It has water capacity for 3,500 gallons, or about 15.5 tons; coal space for 5 tons; and the gross weight when loaded amounts to 40 tons. The line is moderately heavy, with gradients 1 in 178 for three miles and 1 in 200 for five miles.

Tool Holder for Heavy Work.

The Armstrong Bros. Tool Co., Chicago, have recently brought out a tool holder, of which we give two or three illustrations. The holder is a solid steel forging with a square slot through it for the cutting tool. The tool steel used is ⅝ inch square, and the shank of the holder is 2¼ by 1½ inches. The slot in the holder is at a suitable angle to give the best cut to the flat top of the cutter. The set screw holding the cutter is of tool steel. The holder is made both right and left. The right-hand tool may be used for heavy boring. The tool complete is said to cost less than the same weight of Mushet steel in the rough. This holder is designated No. 7.

A New Milling Machine.

We illustrate herewith a new milling machine which has some novel features, notably a cylindrical column, and a cylindrical cross slide, this form having been adopted upon a consideration of the facts that sufficient accuracy of surface could be obtained more easily than with flat surfaces, and that very great rigidity of connection between the knee and column, and between saddle and knee is had by clamping when desired.



NEW MILLING MACHINE.

Another notable feature of the machine is that the one hand wheel shown moves the knee vertically and also the saddle upon the knee. At the center of this wheel is a knob which when pushed in connects the wheel to the horizontal screw which moves the saddle in line with the spindle; when the knob is pulled out the wheel moves the knee vertically, and when in an intermediate position the wheel is free to turn without effecting any movement of the machine, and thus the danger of accidental disturbance can be avoided if desired.

The feed is of the friction type, so arranged as to give ample feeding power and great range. The feed screw is driven by a worm wheel.

The regular feed motion of the platen is 22 inches; in and out traverse, 6 inches; vertical movement of knee, 12½ inches.

The machines are made either with or without back gears, by W. D. Forbes & Co., of Hoboken, N. J., in whose shops similar machines built by them have been in successful use for some time.

Good Centers in Lathe Work—Standard Taper Shanks.

We have before us a small book*, which, though issued primarily for the purpose of further introducing a lathe center grinder, which we have illustrated and described in these columns, is really a treatise upon a subject, the simplicity of which would seem to make its treatment in this manner unnecessary, and yet which experience is constantly showing does need treatment occasionally. It ought to be self-evident to any mechanic worthy of the name that lathe centers should be true, accurate, and uniform in shape, and as hard as practicable, and that the work which is placed upon

*Issued by the Leland & Faulconer Mfg. Co., Detroit, Mich.

them should have good centers, drilled at the bottom, and reamed accurately true with each other, and to accurately fit the lathe centers. Finally, no one is fit to be called a lathesman who does not know that clean centers are an absolute necessity, if good, or even decent lathe work is to be done.

It is, however, the common experience of those who cut gears, do cylindrical grinding, or universal milling machine work for others, that they get a very considerable proportion of work that has been turned in other shops with centers that are entirely unfit to be run upon the centers of their machines.

There are a surprisingly large variety of ways in which the "jammer" can botch the job of centering lathe work, and some of the principal ones are graphically illustrated and held up to ridicule in this book, whose author evidently treats the subject from the standpoint of a mechanic who has suffered from the carelessness of those who, calling themselves machinists, yet utterly neglect this, one of the first and most important requirements of good machine construction. It seems strange that men whose business it is to know, and many of whom do know, the importance of having accurately fitted bearings in machinery, seem to be entirely ignorant of the fact that good lathe work cannot be done without good centers that have good bearings in the work. This book will help to make such men realize the importance of this feature of the business which they should have been thoroughly informed about during the first six months of their apprenticeship, but one difficulty lies in the fact that most of the men who need instruction on this point seldom or never read anything pertaining to their business, and are unlikely to give this book the attention they should give it. They work for "The Makeshift Manufacturing Co.," and the outside world and its doings is all a blank to them.

What this little book has to say about the relative merits of hard and soft live centers is also instructive, and ought to help in raising the average quality of lathe work, and at the same time cheapening its cost.

In the American Machinist of October 31, 1889, there was an article advocating a rational system of taper shanks to be applied to lathe centers, drills, milling arbors, etc. By this system the designating number of each shank indicates its size at both ends, and its length; thus, a No. 10 taper shank would be $\frac{10}{10}$, or 1 inch diameter at the small end; $\frac{10}{8}$, or 1¼ inches diameter at the large end, and $\frac{10}{2}$, or 5 inches long. This gives a taper of one in twenty, or $\frac{6}{10}$ inch per foot.

In this book the general adoption of this as a standard taper shank, under the name of the "Jarno taper," is advocated, and Mr. Leland sends us copies of several letters from well-known mechanics and machinery-building firms endorsing its adoption, and pledging the influence of the writers towards bringing it into general use. It is to be hoped that as far as possible their practice will pull with their influence.

We understand that the Leland & Faulconer Mfg. Co. have definitely adopted this taper, and will use it exclusively. How general its use may become no one can say. If it is but partially accepted it will but add another to the already too great variety of tapers, but if it could, in time, supplant all the others for general use, machine constructors and machine users would certainly be relieved of a present fruitful source of trouble and annoyance, numbers of taper would mean something definite, tapers would be uniform, and taper reamers could be much more readily made a commercial article.

If twist drill manufacturers would supply drills with this shank at the same price as others, and if those who buy lathes, milling machine drill presses, etc., would order them fitted with such tapers, we should soon have this as the regular standard, but some pressure must be exerted by some one n that direction.

An Indicator for Machine Work.

This instrument, of which we give several illustrations, showing its construction and application, is of use in adjusting work, or in testing the accuracy of work upon lathes, planers or other machine tools. Its function is to indicate minute inaccuracies or differences, either of concentricity or of parallelism, in lathe work or any untruth of plane surfaces in the planer or shaper or similar machine. The shank of the instrument, Fig. 1, is to be held as a cutting tool is held in the tool post of a lathe or in the tool holder of any machine. Upon the end of the shank is mounted a hollow steel box turning, with an amount of friction which is adjustable, upon the large central screw. The top of this box is graduated and the indications of the instrument are read from the movements of a pointer at the end of a lever moving in the thin slot which is seen. At the front of the instrument is seen a thumbscrew with a projecting point. This thumbscrew is the feeler of the instrument, or the part to come in contact with the work to be adjusted, or whose accuracy is to be ascertained. Several different shapes of these thumbscrews are provided for different services. A second hole will be noticed just above the hole from which the thumbscrew projects. This second hole gives a different leverage, and, consequently, a different reading. With the screw in the lower hole a movement of $\frac{1}{1000}$ of an inch will cause the pointer to move $\frac{1}{12}$ of an inch, while with the screw in the upper hole $\frac{1}{1000}$ of an inch movement of the screw moves the indicator $\frac{1}{6}$ of an inch, or double as far. The operation will be understood upon looking at Fig. 2. It will be noticed that the movement of the feeler is not in a straight line. This is taken advantage of in the use of the instrument, as either the end thrust may be indicated or a thrust downwards upon the head of the feeler. The graduations read both ways from the center, giving a range of $\frac{7}{1000}$ in each direction from the center or $\frac{14}{1000}$ from the end, when the feeler is in the hole shown. The friction mounting of the box enables it to be set at any angle or to be swung out of the way.

Brass Dowels.

Some of the modes of using the instrument are shown. In Fig. 3 a piece of work is being set upon a face plate so that a center punch mark upon it will be true. For this purpose the spindle with conical point and springing end movements is used. This spindle is furnished with the indicator. Fig. 4 shows the indicator in use for truing the hole in a gear in a lathe chuck. Without changing the indicator in the tool post it will also true the face of the gear. Fig. 5 shows the indicator truing an angle iron upon a planer. Numerous illustrations might be given of the application of the indicator, but they will be evident to any mechanic.

The indicator which we have had the pleasure of examining exhibits excellent workmanship. It is made by John Bath, Hyde Park, Mass.

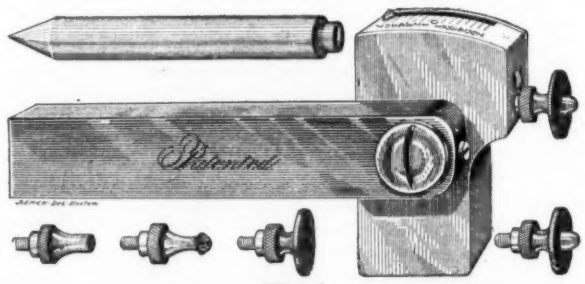


Fig. 1.

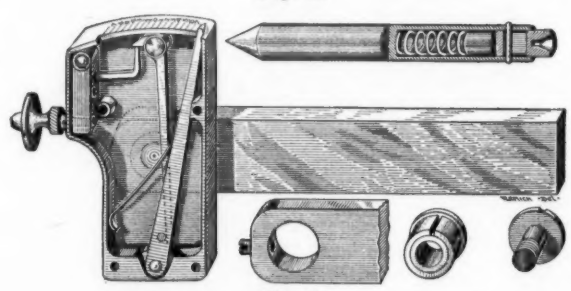


Fig. 2.

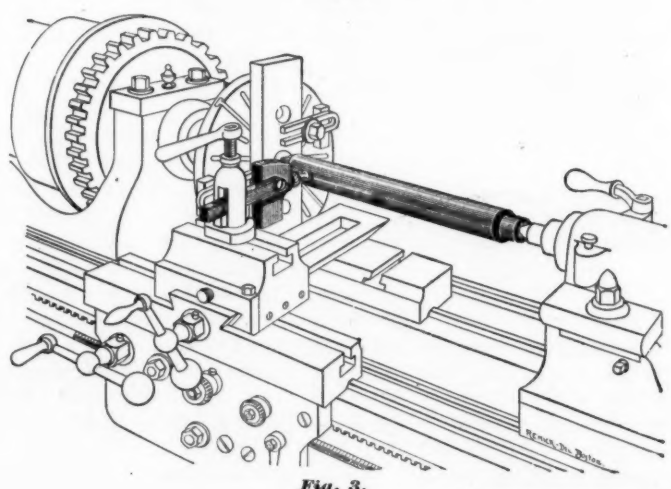


Fig. 3.

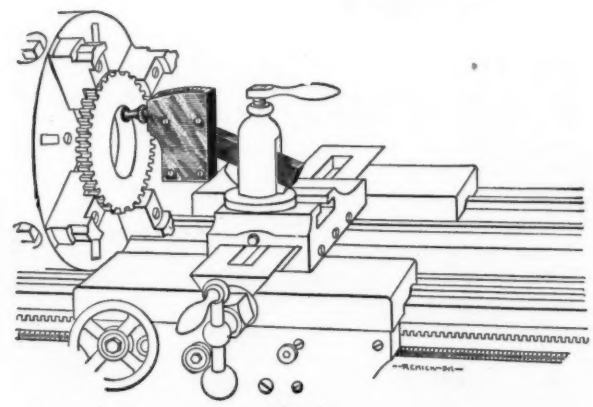


Fig. 4.

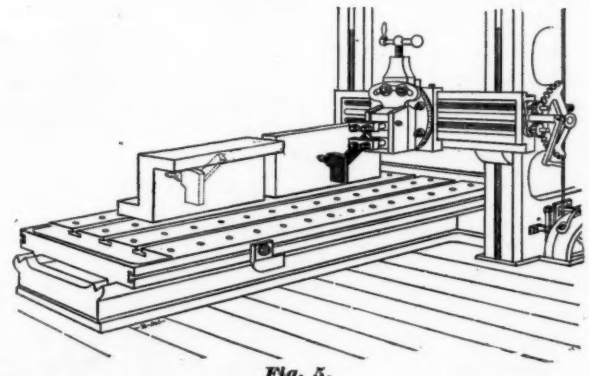


Fig. 5.

Indicator for Machine Work.

Brass Dowel for Patterns.

We illustrate herewith a brass dowel suitable for large patterns. Both parts of this dowel are made of brass, which, while it has sufficient strength, will not corrode. The female part of the dowel is of sheet brass, the other a brass casting, finished to fit, and both are fitted to the pattern by using an extension bit. The engraving shows the dowel full size.

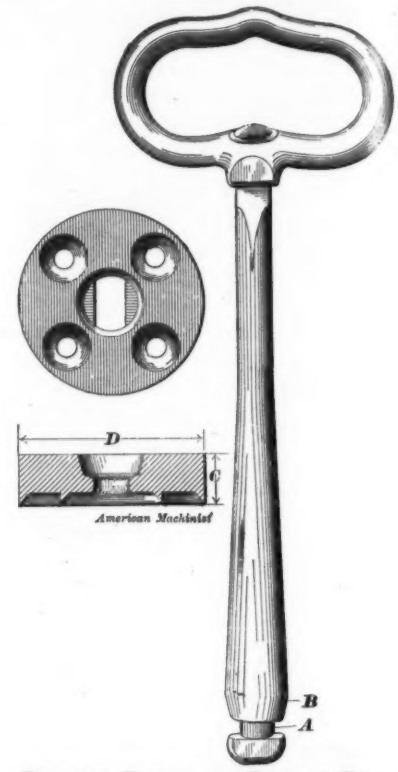
It is made by Timmis & Clissold, Bound Brook, N. J.

Rapping Plates and Lifting Bars.

We illustrate herewith a rapping plate for patterns, and a lifting bar, which, as will be seen, are so arranged that the plate can be applied to the pattern by boring a seat with an extension bit, and there being no threads, a quarter turn of the hook locks it or releases it from the pattern. The plates are made of gray iron, malleable or steel, and the bars are drop forged. The handle, when it is pushed down upon the bar, fits over the square shown, and thus enables the locking to be done, but when lifted is free to turn in any position. The object of the slight upward bend in the middle of the upper portion of the handle is to prevent slipping when the hook of a hoist is attached.

The form adopted is that which experience has shown to be well suited to the purpose.

The manufacturer is W. S. Hawker, 620 McLain street, Dayton, Ohio.



Rapping Plate and Lifting Bar.

A Novel and Remarkable Engine.

"A New Departure in Steam Engine Economy" was a part of the title of a recently published paper by Professor Jamieson, of the Glasgow and West of Scotland Technical School. This paper is the subject of editorial remark in *The Engineer*, London, in a recent issue, and a number of

curious things are brought to notice. The paper referred to is a report of tests of a Field engine conducted in November, 1894. The peculiarity of this engine consists in forcing highly heated air into the cylinder during the exhaust stroke, preventing, in theory at least, the cooling of the cylinder and initial condensation. This air, is, of course, most of it expelled again, and only a little remains during compression to mingle with the next cylinderful of live steam.

"A Root blower, driven by the engine, draws fresh, cold air from the engine room, and forces the same through a series of heating pipes placed in the main flue between the boiler or boilers and the chimney. This heater, therefore, occupies pretty much the same position as a Green economizer. The air was maintained, in my experiments, at a mean pressure of 1¼ pounds on the square inch, and delivered to the ends of the cylinder at a mean temperature of 553° Fahr., and to the valve-casing jacket at about 380° Fahr. This hot air was admitted to the cylinder through special cylinder covers, each containing five inlet valves, which automatically opened inwards as soon as the exhaust steam commenced to escape. These valves continued open until compression commenced, being held close to their seats by light spiral springs. Consequently the whole internal surface of the cylinder was heated up to a temperature far exceeding that of the steam, thus preventing the possibility of condensation taking place within the cylinder. Under these circumstances I got the excellent result of 18.6 pounds of steam per indicated horse-power per hour from a single cylinder non-condensing engine—a result which, as far as I can learn, has never been equalled by any other method of using steam in a single cylinder, and without subsequent condensation."

This apparently "excellent result" shows us how some such excellent results are obtained. While the indicated horse-power was 136.75, the brake horse-power was only 104.6, showing a loss of 24 per cent. in the apparatus. The cylinder was 19 inches by 3 feet, and the revolutions were 81.66 per minute. The engine had four Corliss valves, but the steam and exhaust valves at each end were so close that the incoming steam had to pass over surfaces cooled by the exhaust. The passage from the boiler to the valve chests was not specially free, yet the pressures in the cylinder and in the boiler were frequently identical, and sometimes the initial pressure in the cylinder was higher than the boiler pressure. The diagrams produced were not at all like Corliss diagrams, but rather like those from a locomotive much linked up, the compression being enormous, while the expansion was always precisely down to atmosphere and no lower. This engine, it seems, could open its exhaust port at the precise moment when the pressures inside the cylinder and outside of it were identical, whether the engine was indicating one fourth power or full power.

The Engineer assumes that the engine would have an initial condensation of 30 per cent., or, say, about 800 pounds per hour, thus giving up to the cylinder walls at least 720,000 heat units in the same time. The conclusion of the article is interesting reading.

"We may take it for granted that Professor Jamieson's conclusions are quite accurate. We may accept without question the theory that the admission of highly heated air in this way into a cylinder will very largely promote economy. But it remains none the less a fact requiring explanation how it is that the hot air—supplying at the most 130,000 units, and probably nothing like that quantity, to the metal of the cylinder and piston—can do that which steam has to supply 720,000 units to effect. It is certain that 720,000 units supplied by an ordinary jacket could not do more. The whole story is wonderful. Let us hope that further experiment will confirm the results obtained by Professor Jamieson. What, it is fair to ask, has been done with what is, on the face of things, a very valuable invention, since November, 1894?"

Fly-Wheel Arms.

By Prof. C. V. Kerr.

During the discussion of this question some confusion has arisen through looseness in use of the terms "stress" and "strain." In order that we may all understand those terms in the same way, let me quote from Professor Johnson's "Modern Framed Structures:" "Strain is the distortion of a body caused by the application of one or more external forces." "Stress is the resistance of a body to distortion." Within the elastic limit, "stress and strain are proportional, equal increments of one always producing equal increments of the other." "The definitions here given conform to the practice of the leading authorities." In other words, an external force distributed within a body becomes *stress*, and the internal disturbance bringing into play the molecular forces to resist the force applied becomes a *strain*, which appears externally as bending, twisting, etc.

In the American Machinist, April 18, 1895, Mr. Guy offers an analysis of this question, and compares the deflection of an arm fixed at both ends with that of an arm fixed at hub and free at rim, finding that for the fixed arm, "the deflection of an arm of uniform section of length, L, is at the limit 1.26 times that of an arm firmly fixed at the hub, and loaded at its point of junction to the rim." But his assumption is, naturally enough perhaps, that the stress in extreme fiber

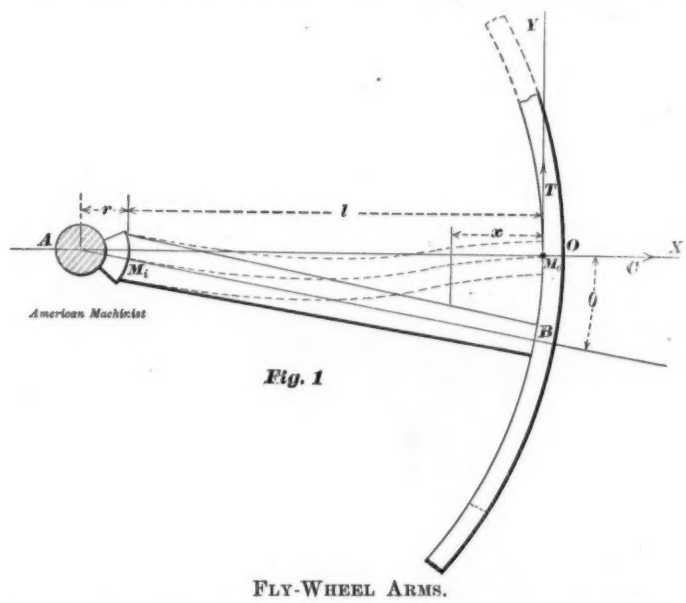


Fig. 1

Fly-Wheel Arms.

should be the same for both arms. Now the moment at the hub for the free arm is double that for the fixed arm, and the moments of resistance will have the same ratio. Hence, the fixed arm has much the smaller section. Let us make two other allowable assumptions. Suppose, first, that the stress in the fixed arm varies with the distance from the neutral axis at the same rate as in the free arm; that is, let $f_1 = f.\frac{h}{H}$, using Mr. Guy's nomenclature. Then we shall have $B = b\sqrt[4]{2}$, $\frac{I}{I_1} = 2$, $\frac{\triangle}{\triangle_1} = 4$, $\frac{\tan. 2\alpha}{\tan. \Theta} = \frac{r+L}{2r+L}$. Now for $r = o$, tan. 2α = tan. Θ; and for $r = \frac{1}{4}L$, a common value, tan. $2\alpha = 0.9$ tan. Θ. In other words, for proportional stress and an actual wheel, the deflection will be less for the fixed than for the free arm, although the fixed arm still has the smaller section.

Again, let us assume the fixed and free arms to have the same section at the hub, which would seem a good basis for a just comparison. Then we shall have from Mr. Guy's equations, $f_2 = \frac{1}{2}f$, $B = b$, $\frac{\triangle}{\triangle_1} = 8$, $\frac{\tan. 2\alpha}{\tan. \Theta} = \frac{r+L}{4r+2L}$. Then, as above, for $r = o$, tan. $2\alpha = 0.5$ tan. Θ, and for $r = \frac{1}{4}L$, tan. $2\alpha = 0.45$ tan. Θ.

Does not this look as though the fixed arm of uniform section would have the advantage over the free arm either when equal sections at hub or equal deflections of arms are assumed? At least, manufacturers have usually sought to make the fly-wheel arms "fixed" at each end, although they have not usually made them of uniform section.

To Mr. Guy's reasons for assuming the straight radial arm to be the best, let me add the fact that such an arm will work better in the reverse direction than will the curved arm. The conditions under which I concluded, not assumed, that the section should be uniform will appear in the analysis which follows:

In the hope of carrying the discussion to a point where practical results may be obtained, I submit the following analysis which seems to me sufficiently exact to cover all essential points while leaving out certain small and complex effects. Let us assume the arm to be deflected to an angle Θ at which the applied and resisting forces are in equilibrium. The forces applied are due to inertia, the one, C, acting radially, and commonly called centrifugal force; and the other, T, acting at right angles to C, or tangentially, due to change in speed of rotation. The diameter of rim will be assumed to remain constant. Whether the arm is to be uniform in section or tapered will depend upon the interpretation of results. We assume also that the arms are rigidly held at hub and rim, from which it follows that the neutral axis of arm will remain tangent to radii at the two ends of the arm. This applies quite exactly to heavy, square rim fly wheels designed for such duty only. Where the hub and rim may yield more or less, as in band fly wheels, it applies less exactly.

Then in Fig. 1, which may be taken to represent the assumed conditions, we shall have for the equation of moments for any section with origin at o,

$$E\,I\frac{d^2y}{dx^2} = T\,x - M_o \qquad (1)$$

where M_o is a moment due to the arms being held rigidly. Further,

$$E\,I\frac{dy}{dx} = \tfrac{1}{2}\,T\,x^2 - M_o\,x + (\text{constant} = o) \qquad (2)$$

Since the natural sines and tangents of small angles up to nearly 3 degrees agree to the fourth decimal place, we may assume for neutral axis tangent to radii,

$$E\,I\frac{dy}{dx} = E\,I\ \text{tan.}\ \Theta = E\,I\,\Theta = \tfrac{1}{2}\,T\,x^2 - M_o\,x = \tfrac{1}{2}\,T\,l^2 - M_o\,l, \text{ for } x = l.$$

Then,

$$M_o = \tfrac{1}{2}\,T\,l - \frac{E\,I\,\Theta}{l}. \qquad (3)$$

Substituting M_o in equation (1),

$$E\,I\frac{d^2y}{dx^2} = T\,x - \tfrac{1}{2}\,T\,l + \frac{E\,I\,\Theta}{l} = \tfrac{1}{2}\,T\,l + \frac{E\,I\,\Theta}{l} = M_i, \text{ for } x = l. \qquad (4)$$

At the beginning of deflection when $\Theta = o$, or after deflection, if tangents to neutral axis at ends of arm remain parallel, we should have $M_i = M_o = \frac{1}{2}\,T\,l$, which conditions call for an arm of uniform section since the moments at the ends are equal. The centrifugal force of the arm itself, however, calls for a slight taper toward the hub. But the first condition supposes that the force T is suddenly applied at full value, as it may be; and the second, that the rim section of arm is turned outward relatively by the angle Θ, which it would not be.

Again from equation (4) $E\,I\frac{dy}{dx} = \frac{1}{2}\,Tx^2 - \frac{1}{2}\,T\,l\,x + \frac{2\,I\,\Theta\,x}{l} + (\text{const.} = o)$. And $E\,I\,y = \frac{1}{6}\,T\,x^3 - \frac{1}{4}\,T\,x^2 + \frac{E\,I\,\Theta\,x^2}{2\,l} + (\text{const.} = o)$. (5)

For small angles $y = r$ sin. $\Theta = r\,\Theta$, when $x = l$.

Then $E\,I\,r\,\Theta = \frac{1}{6}\,T\,l^3 - \frac{1}{4}\,T\,l^3 + \frac{1}{2}\,E\,I\,\Theta\,l = -\frac{1}{12}\,T\,l^3 + \frac{1}{2}\,E\,I\,\Theta\,l$, from which $\Theta = \frac{T\,l^2}{6\,E\,I\,(l-2\,r)}$, or $I\,\Theta = \frac{T\,l^2}{6\,E\,(l+2\,r)} =$ a constant for any given value of T. Hence we cannot make $\Theta = o$ as that makes $I = \infty$. And also $\frac{E\,I\,\Theta}{l} = \frac{T\,l^2}{6\,(l-2\,r)}$.

Hence $M_o = \frac{1}{2}\,T\,l - \frac{T\,l^2}{6\,(l-2\,r)} = \frac{T\,(l^2 - 3\,l\,r)}{3\,l - 6\,r}$, (6)

and $M_i = \frac{1}{2}\,T\,l + \frac{T\,l^2}{6\,(l-2\,r)} = \frac{T\,(2\,l^2 - 3\,l\,r)}{3\,l - 6\,r}$. (7)

Now if we make $r = o$ in equations (6) and (7), we shall have $M_o = \frac{1}{6}\,T\,l$, and $M_i = \frac{2}{3}\,T\,l$. Further, to find the point of reverse curvature in the arm, substitute M_o from equation (6) in equation (1), and make the sum of moments zero; that is, $E\,I\frac{d^2y}{dx^2} = o = T\,x - \frac{T\,(l^2 - 3\,l\,r)}{3\,l - 6\,r}$, from which we obtain $x = \frac{l^2 - 3\,l\,r}{3\,l - 6\,r}$ as the distance from outer end of arm to the desired point.

Again, if we make $r = o$, $x = \frac{1}{3}\,l$. This agrees with Mr. Begtrup's conclusion as expressed in the American Machinist March 21, 1895. But the making of $r = o$ reduces the hub to a line and leaves the inner ends of the arms without support. Hence we cannot neglect the small quantity r, as Mr. Begtrup seems to have done.

The deflection of the arm introduces a moment due to centrifugal force $C\,y$, in which the lever arm y is so complex a function of x that it has not been considered in the equation of moments. Its tendency is to straighten the arm. So we may get a probably nearly correct value for it by making it $C\,r\,\Theta$ for the inner end of arm. We may introduce this value in equation (7), making $M_i = \frac{T\,(2\,l^2 - 3\,l\,r)}{3\,l - 6\,r} - C\,r\,\Theta$, which is the only change necessary, since $C\,y = o$ for the rim end. But I have, from measurements taken on the fly wheel of a 100 horse-power Corliss engine, found the value of the deflection of the arm for a stop in one second from the normal speed of 76 r. p. m. to be $\Theta = \frac{T\,l^2}{6\,E\,I\,(l-2\,r)} = .001564 = 0°\ 5'$ nearly, and that the moment $C\,r\,\Theta = 97.2$ inch-pounds, which was an eighth of one per cent. of the total moment. So I should say that $C\,r\,\Theta$ is a small quantity which we may safely neglect, especially as the resulting section at hub will be larger.

The possible yielding of hub and rim introduces an uncertainty of which we cannot take direct account in our analysis; but neither M_o nor m_i depends upon the deflection as shown by equations (6) and (7). Hence the effect of yielding would be merely to increase the angle of deflection as measured between radii. The forces C and T will still be radial and tangential.

To find the section of arm for any desired wheel, we must make the moments of resistance of the arm at hub and rim equal to M_i and M_o respectively. For elliptical arms, the most usual form, the moment of resistance, R, $= \frac{1}{32}\,\pi\,s\,t\,b^2$, where s = safe working stress in extreme fiber in pounds per square inch, t = thickness of arm in inches and b = breadth of arm in inches. Or, $R = \frac{1}{32}\,\pi\,s\,m\,b^3$, where m = assumed ratio of t to b. Then for rim section of arm, $R_o = M_o = \frac{1}{32}\,\pi\,s\,m\,b_o^3 = \frac{T\,(l^2 - 3\,l\,r)}{3\,l - 6\,r}$, from which $b_o = \sqrt[3]{\frac{32\,T\,(l^2 - 3\,l\,r)}{\pi\,s\,m\,(3\,l - 6\,r)}}$, or $s = \frac{32\,T\,(l^2 - 3\,l\,r)}{\pi\,m\,b^3\,(3\,l - 6\,r)}$, and $t_o = m\,b_o$.

Similarly for hub section,

$b_i = \sqrt[3]{\frac{32\ T\ (2\ l^2 - 3\ l\ r)}{\pi\ s\ m\ (3\ l - 6\ r)}}$ and $t_i = m\ b_i$, or $s = \frac{32\ T\ (2\ l^2 - 3\ l\ r)}{\pi\ m\ b^3\ (3\ l - 6\ r)}$. Hence by assuming the length of arm l, and radius of hub r, both in inches, the safe working stress s, and the load T in pounds, we may determine with all needful accuracy the cross-section of arm at inner and outer ends.

The direct tension of centrifugal force must also be allowed for; but as we cannot distribute it until we know the area of section, $A = \frac{1}{4}\ \pi\ t\ b$, of arm as determined above, it will be necessary to make s small enough so that $s + \frac{C}{A}$ shall not exceed a certain safe working stress.

To show how these formulæ may be used in fixing dimensions of arms, take the case of an 800 horse-power tandem compound, with cylinders 20 + 38 × 48 running at 100 r. p. m. The band fly wheel is 18 feet in diameter, with 52-inch face and eight arms of elliptical section; it weighs, rim, 37,250 pounds; arms, 9,920 pounds; hub, 6,530 pounds, a total of 53,700 pounds. The diameter of hub is 32 inches, and net length of arm 84 inches. The rim velocity is $v = \frac{\pi \times 18 \times 100}{60} = 94.25$ feet per second. The weight of rim on each arm is 37,250 ÷ 8 = 4,660 pounds, nearly. Assume a safe working stress in tension for cast-iron of 3,000–5,000 pounds per square inch, and that the thickness of arms equals half the breadth, or $m = 0.5$. Now, it may be shown that the stretching of the rim of a fly-wheel due to its own centrifugal force increases the radius of the wheel by an amount very nearly three times the stretch in the arm due to its own centrifugal force. Hence, only two-thirds of the centrifugal force of the rim segment will be felt by the arm. Then for this case the centrifugal load on the arm will be, $C = \frac{2}{3} \cdot \frac{m\ v^2}{r} = \frac{2}{3} \times \frac{4{,}660}{32.2} \times \frac{94.25^2}{8} = 107{,}130$ pounds.

Now, the kinetic energy of the segment will be $E = \frac{1}{2}\ m\ v^2 = m\ v \cdot \frac{1}{2}\ v = T \cdot a$ = force × space, where v is the velocity gained or lost per second, and $\frac{1}{2}\ v$ is equal to the space passed over in starting or stopping. If the start or stop were made in ten seconds instead of one, the value of E would remain the same, that is, $E = \frac{1}{10}\ m\ v \times 5\ v = \frac{1}{10}\ T \times 10\ a$.

Assuming then that the wheel is to stand the strain of stopping in one second we shall have $T = m\ v = \frac{4{,}660 \times 94.25}{32.2} = 13{,}640$ pounds. Then for the outer end of arm,

$$b_o = \sqrt[3]{\frac{32\ T\ (l^2 - 3\ l\ r)}{\pi\ s\ m\ (3\ l - 6\ r)}} = \sqrt[3]{\frac{32 \times 13{,}640 \times 3{,}024}{\pi \times 3{,}000 \times 0.5 \times 156}} = 12.2'',$$

and $t = 6.1''$.

The area of section $= \frac{1}{2}\ \pi\ t\ b = 58.4$ square inches, and the uniform stress due to centrifugal force of rim will be 107,130 ÷ 58.4 = 1,830 pounds. Then the greatest stress per square inch at outer end of arm will be 3,000 + 1,830 = 4,830 pounds, which is within the limits set. For the inner end of arm,

$$b_i = \sqrt[3]{\frac{32\ T\ (2\ l^2 - 3\ l\ r)}{\pi\ s\ m\ (3\ l - 6\ r)}} = \sqrt[3]{\frac{32 \times 13{,}640 \times 10{,}080}{\pi \times 3{,}500 \times 0.5 \times 156}} = 17.3'',$$

and $t_i = 8.6''$.

The area of section = 117.4 square inches, and the centrifugal stress will be 107,130 ÷ 117.4 = 913 pounds. The stress at hub due to centrifugal force of arm itself may now be approximated. The weight of arm $= \frac{1}{4}\ (117.4 + 58.4) \times 84 \times 0.26 = 1{,}920$ pounds, which may be assumed as concentrated at center of gravity of arm about 4.75 feet from center of hub. Then $C = \frac{m\ v^2}{r} = \frac{1{,}920 \times 59.4^2}{32.2 \times 4.75} = 44{,}285$ pounds, which distributed over 117.4 square inches gives 377 pounds per square inch. Then the greatest stress at hub will be 3,500 + 913 + 377 = 4,790 pounds.

It would be easier and perhaps even advantageous to consider the whole centrifugal force of the rim, instead of only two-thirds, as borne by the arm and ignore the centrifugal force of the arm itself. The effect would be to make the sections of arm at hub and rim more nearly equal. This would enable the arm to withstand better a suddenly applied load caused perhaps by breakage of machinery, and also to remain unbroken longer, should the wheel go to pieces through increased speed, since for that case the rim end is the weakest section. The arm above would stand a speed of not more than 300 revolutions per minute, if the ultimate strength of the cast-iron were 16,000 pounds per square inch. The wheel as actually constructed had a rim section 11x5½, and a hub section 14x6. It would seem proper to design fly wheels to stand stopping in one second or less, or to accelerate at least to double the normal speed without reaching a danger point.

There may be errors of one kind or another in the foregoing analysis, or in the reduction of formulæ, but the whole has been worked over carefully, and is believed to be sufficiently accurate.

LETTERS FROM PRACTICAL MEN.

Stresses on Cylinder Head Bolts.

Editor American Machinist:

Is the initial stress put on a cylinder head bolt by the wrench, in screwing it up, to be deducted from its strength to resist the force of the steam pressure? I suppose not. The steam pressure merely takes the place of the resistance of the cylinder flange until the full amount of the initial stress has been reached. It is entirely a case of substitution.

To prove this introduce springs on the bolts under the nuts and screw these down to a certain compression. No additional stress can come on the bolts unless the springs are compressed further. That is certain. Now admit to the cylinder steam of a pressure not sufficient to produce further compression of the springs and open the joint. It is evident that the steam is partially relieving the cylinder flange from pressure, and that is all.

The flanges of the cylinder and head being of proper thickness the pressure is distributed over a considerable extent of their surfaces, and no elastic yielding of these surfaces can take place. The bolt only suffers elongation.

Before this further elongation can occur, permitting the joint to open, the steam pressure must exceed the initial stress on the bolt, entirely relieving the pressure on the flange. If this were not the case, the least pressure of steam would open a joint, however tightly it might be screwed up.

Charles T. Porter.

Elasticity in Bolts.

Editor American Machinist:

I wish to say just a word to back up Mr. J. E. Johnson, Jr., in what he says in your July 11th issue on "Bolt Tension."

I have had considerable experience with bolts and their working under strain, and I know that there is a great deal of elasticity in a good quality of iron.

Now to cite a case to the point, the boiler in our shop primed or foamed, and the water siphoned over into the engine (a Putnam 16 inches by 32 inches running 65 revolutions) so much that it stopped the engine in three or four revolutions. I was near the engine at the time, and went to it as soon as it commenced to pound.

The head sprung away from the cylinder at least ⅛ inch at every revolution, and the steam and water came out in a sheet all around the head.

As soon as we could I started the engine again and fully expected the head would leak, but it was just as tight as a drum, and we run right along without any leak developing.

Now if there had been no "spring" in the bolts in the heads, and they had simply stretched when the strain came on them, they would never have come back to place without tightening the nuts.

This proved conclusively to my mind that a bolt under certain conditions is a spring, or, rather, has a spring action.

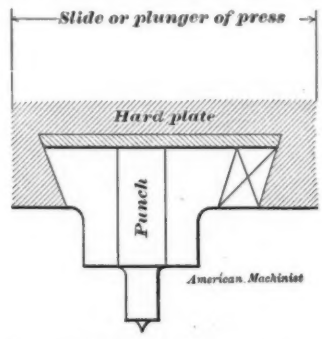
I will add that the only thing that saved the head at the time was that we had put a relief valve on each head in anticipation of such an occurrence. I would like to hear from some experienced engineers about a relief valve in a cylinder head. Should it be placed at the bottom of the head, or is it just as serviceable in the center?

A. S. Richardson.

Making Small Punches—Annealing Steel.

Editor American Machinist:

I see in your issue of July 4th, a communication from Mr. Hyde, in which he complains of difficulty in getting punches to stand. I once had a similar difficulty, and this is the way I overcame it. I made the punch, as shown in sketch, using an ordinary power press. I made the punch much the same way as he describes, but turned a small tit on the end, as shown, the object being to hold the metal from sliding or slipping on the face of the die. The small end of punch should be as short as possible, say ¼ inch longer than is needed to clear the stripper (if one is used). I found this



method to work much better than when the punches were flat on end, although I had to make more punches, as this style could not be ground as they got dull.

I have had good success in annealing tool steel in this way: Heat the pieces as for hardening in a coke fire, and cover in charcoal ashes until cold.

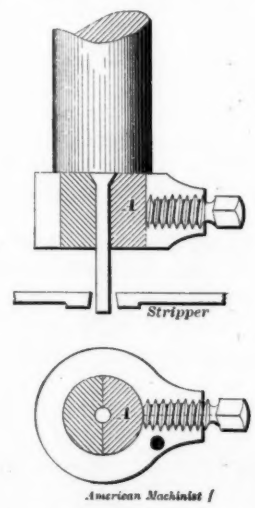
I would mill the grooves in the rolls, as I understand they are straight grooves, not screw threads, and to bore the hole for one inch shaft would first chuck a rough hole $\frac{1}{16}$ inch smaller than finished size, then with a lathe boring tool bore the end for about one and one-quarter diameters, that is, 1¼ inches deep to fit rifle drill, and finish the hole with an ordinary rifle drill, leaving $\frac{1}{100}$ inch to ream with a rose reamer, using good lard oil in reaming and drilling.

G. A. B.

Making a Small Punch.

Editor American Machinist:

I send you a sketch and a few points that may help the Asa P. Hyde Machinery Company out of their trouble with broken



punches. We had the same trouble they complain of—the punches broke badly. The holder is the same as theirs, except that the set screw does not strike the punch, but on the clamp *A*, and a punch cannot get stuck and give trouble in getting the shank out.

The punches break in drawing out and not in punching the hole, and if they will make the stripper so it bears evenly next the punch and not on one side of the hole, I think they will have no more trouble.

The best way I have found to anneal tool steel is to buy it from the makers in that shape, as I have never been able to anneal it anywhere near as good as we can buy it, and the extra cost is not to be considered as compared with the results obtained.

Lynn, Mass. J. L. Lucas.

Making Small Punches—Annealing Steel.

Editor American Machinist:

In reply to the letter concerning punches, annealing steel, etc., I would say that the cutting of $\frac{1}{16}$ inch steel with a $\frac{3}{16}$ inch punch and die is not a difficult operation.

The solid punch was 3 or 3½ inches long, $\frac{1}{8}$ inch or $\frac{5}{8}$ inch of length turned to $\frac{3}{16}$ inch. The cause of the trouble is plain; the part turned to $\frac{3}{16}$ inch is about six times too long.

The same thing will probably explain the trouble with the drill rod punch and holder.

In the case of the drill rod, loose pin and holder, that will, if the rod is a good fit, and extends only ¼ inch beyond the holder, doubtless stand up to the work, but when the punch wears, and is ground off to sharpen, a longer loose pin will be needed to keep it from pushing up. A common way to make punches for such work is as follows:

Taper ream the holder now in use, if it is long enough to reach die, with a ¼ inch, 2 degree reamer.

Ream and fit a short plug to the spindle of a light lathe. No set screw will be needed, and a tempered pin only should be used to drive out broken or worn-out punches. Turn or file the shank, of punches to fit the holder, put them in the plug and turn to size. Harden in oil, and heat the shank to draw, leaving end of punch dark blue, and a pale blue or gray where it tapers off.

With this short punch the hole in stripper will have to be tapered out to allow the punch to reach the die. You can use center reamer for this.

To anneal take a large pot or box of wood ashes, and bury the steel to some depth.

Nutmeg.

Fancy Screws, but What About the Taps?

Editor American Machinist:

In the table of pitches for the proposed new screw thread, published in your issue of March 28th, I found quite a puzzle, and the more I think of it the more puzzling it seems.

I have known of men sending green apprentices after ¼ inch 8 P. taps, and in Mr. Dix's table I find ¼ inch 10 P. I knew that the man was trying to fool the apprentice, and I am puzzled to know if Mr. Dix is trying to fool the readers of the American Machinist.

For want of a better knowledge of the matter, I shall presume that in order to make ¼ inch screws and nuts, that a tap will be needed, and that the tap must be strong enough to resist the strain of driving.

Now a tap made of the best tool steel .270 inch outside diameter and .150 inch at bottom of thread, and properly fluted, would have very little to hold it together, and in my humble judgment it would require something to hold before it could be made to cut such a thread.

Perhaps it would be possible to do such a thing by using many taps of varying diameters, but I doubt if it could ever be made practical.

Before suggesting a reformation it is customary, I believe, to cite horrible examples.

I should consider the "Acme Standard" ¼ inch 10 P. horrible enough, and next to it I should place ¼ inch 20 P., V, or U. S. standard. I have never been able to make such a tap stand in anything near a satisfactory way. It would be interesting to hear the experience of others with coarse pitch, small diam-

cter taps. Are such taps necessary? Many years ago, when all screw threads were merely hollow burrs thrown up on a rod or in a nut, there might have been good reason for coarse pitches. I believe to-day, with the good tools in use, that ¼ inch 28 or even 32 P. is a much more lasting thread than ¼ inch 20 P. used to be when cut with an old jam plate, and the nut tapped with a taper plug without much attempt at cutting edges.

The practical difficulties in the way of cutting the threads in the nuts as called for by this "Acme Standard" table is not the only thing that bothers me. I fail to understand the use of such a table at all. This "Acme Standard" was suggested to take the place of square thread screws.

Now, for the greatest number of cases (I might safely say 9 out of every 10 cases) where square thread screws are used, the pitch and diameter must conform to the requirements of the particular machine for which they are intended. If the designer wants 1 inch 16 P. he is going to have it regardless of anyone's rules.

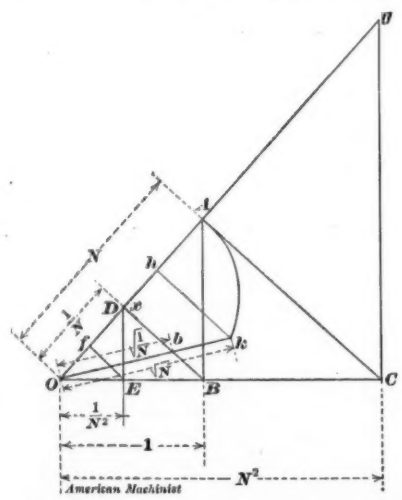
The standard screw threads already in use apply only to common bolts and nuts, and pipe threads. This table of pitches, it seems, will not do for bolts and common holding screws—certainly not for pipe threads—doesn't look reasonable for slide actuating screws, and is not practical in other respects, so, as I said before, it is rather puzzling. A MECHANIC.

Graphical Methods of Calculating.

Editor American Machinist:

The graphical methods of finding square roots, squares and reciprocals, given by Mr. R. E. Horton, in your issue for May 16th, appear to me to be needlessly complicated, and I venture to think that he will find the following construction superior in many respects to the several solutions he submits.

In the sketch, $O\ C$ is a line on which lay off $O\ B = 1$. At B raise a perpendicular,



and from O as center and length $= N$, cut this perpendicular in A. Join $A\ O$ and draw $A\ C$ and $D\ B$ both perpendicular to $O\ A$, and $D\ E$ perpendicular to $O\ C$. Mark off $O\ h = 1$, and draw $h\ k$ perpendicular to $O\ A$. From x, the middle point of $O\ A$, draw the arc $A\ k$ and join $k\ O$. Then

$O\ k = \sqrt{N}$; $O\ l = \sqrt{\frac{1}{N}}$; $O\ C = N^3$; $O\ D = \frac{1}{N}$ and $O\ E = \frac{1}{N^2}$. This construction may be continued in both directions. Thus, by drawing from E a perpendicular to $O\ A$, we obtain $O\ f = \frac{1}{N^3}$, and so on, the *odd* negative powers being obtained on $O\ A$ and the *even* negative powers on $O\ C$. In the other direction, by raising a perpendicular at C, cutting $O\ A$ produced in g, we obtain $O\ g = N^3$, and continuing in this way, the successive positive powers of N can be obtained, the *odd* powers being always found on $O\ A$ produced, and the *even* powers on $O\ C$ produced. As will be seen, the above construction supplies in one simple diagram all that Mr. Horton required, and a good deal more. Nevertheless, I question very much if the most suitable applications of graphic construction are found in applying it to the solution of such a problem as that which your contributor refers to. Since it is shown that a close approximation to absolute accuracy was sufficient for the purpose, Mr. Horton would have found the slide rule of far more value than his drawing board. With the modern instrument (Mannheim type) the procedure is very simple, and consists in inverting the slide, and placing the end indices coincidently. Any value of $\frac{1}{N^3}$ is then read off on the A scale over the value of N on the C scale. Nothing can be simpler than this, as Mr. Horton will discover very speedily.

There is, no doubt, a necessity for carefully discriminating between the various methods of solving such problems as are of more or less frequent occurrence in the drafting room. For many purposes the slide rule is of the utmost possible assistance, but it is easy to find instances where it is totally unsuitable, or at best but ill-adapted. The same may be said of graphic methods of calculating, for it cannot be gainsaid that one or two of the complicated diagrams which occasionally adorn the pages of some of the electrical journals, afford abundant evidence of the inadaptability of this method of solving certain of the problems which are met with by the electrical engineer. At the same time, much useful work may be accomplished by the *reasonable* use of the graphic method of calculating, and there is no doubt that much greater use will be made of it in the near future. With the graphic *diagram*, the engineer has now become perfectly familiar (although the fullest uses are not yet made of it, as I hope on another occasion to show) and the further development of graphical calculation will doubtless follow as a matter of course.

M. E.

Annealing Steel.

Editor American Machinist:

Your editorial and the letter signed "P. D.," in issue of July 4th, induce me to say a few words about my experience with annealing large work.

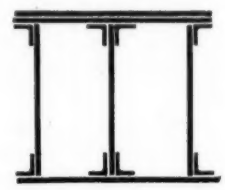
The Committee on Standard Tests and Methods of Testing Materials, A. S. M. E., has been investigating the behavior of metals while cooling from high temperatures and has made some interesting experiments, obtaining probably very valuable results.

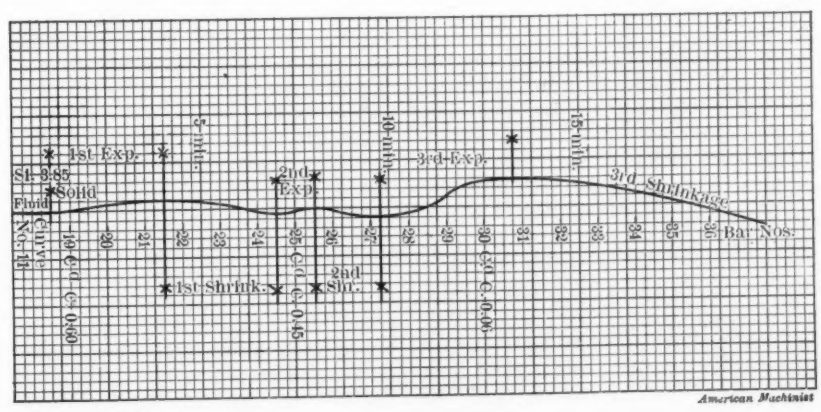
An apparatus was built by W. J. Keep, of Detroit (member of the above committee), which would correctly show what occurs in bars of iron, steel and other metals while cooling; the curve as shown is one recorded by this apparatus when attached to a one-inch square bar of cast-iron. This bar of 3.85 silicon iron was poured at the instant indicated by extreme left end of diagram; the card on which this curve was recorded was wrapped around a drum and moved at the rate of 5 minutes per inch of circumference, while the shortening or lengthening of the bar caused a pencil to trace a line below and above the horizontal through the starting point. It was noticed that the pencil remained stationary for about 1 minute, then it rose above the line for 3 minutes, when its motion was reversed for 3 minutes, then again rose for 1 minute, after which it once more fell for 1½ minutes. At this moment the pencil rose rapidly and greatly until the end of the 13th minute after pouring, from which time the pencil gradually fell until its position, after the bar had become cold, indicated the total shrinkage of bar.

Now, these variations in the motion of the pencil show the working of the bar while its constituent molecules arrange themselves, being in a state of complete solution in iron while the metal is molten. Investigation showed that the combined carbon gradually separated out until, at the end of the 13th minute, the iron contained its final quantity of combined carbon, which would not change during further cooling, whether slow or fast. If the bar had been cooled suddenly and entirely before the end of the 13th minute, the amount of carbon then in combination would have become fixed and remained greater than if the bar had cooled naturally.

To prove this, 18 similar bars were poured simultaneously with the one-inch square bar to which the recorder was attached, and each minute thereafter one of these bars was taken from the sand, broken instantly and one-half plunged into ice water; the other half was allowed to cool in air. It was found that the bars were solid at the end of the first minute, and that all air-cooled pieces had the same combined carbon as the large test bar after cooling, while analysis of quenched bars 19, 25 and 30 showed combined carbons of 0.60 per cent., 0.45 per cent. and 0.06 per cent. It must be borne in mind that the recorder showed nothing but end motion after the bar had become solid.

Now in hardening and annealing steel we find a precisely similar state of affairs. If a bar of steel is quenched at a very high heat all its carbon remains in combination, producing a very white and bright structure; as the same bar is quenched at lower temperatures color of fracture grows darker until a point is reached at which quenching produces no further change in molecular arrangement. It has been previously determined that this change of color and structure was due entirely to the amount of carbon remaining in combination, being higher when quenched at a higher temperature; it is known that these changes are truly indicative of hardness (temper). But if on the contrary sudden changes are carefully prevented then the metal will be soft, uniform in molecular arrangement, in fact, annealed. It was shown above that quenching after a certain period did not produce changes in structure; likewise a bar after reaching this period can be cooled as rapidly as possible without producing further structural change, and it is not necessary to wait until entirely





ANNEALING STEEL.

cold, before removing it from muffle, furnace or box, and cooling very rapidly. It must not be forgotten that dropping a very hot piece of metal onto a larger block of cold metal, the ground, into ashes, or a box of lime, may effectively quench the metal; even a large, cold pair of tongs may produce the same effect.

Formerly it was customary to put a quantity of large steel bars into a furnace, and then start a new, brisk fire playing directly upon them, until furnace and bars together had reached a high heat; then the fire was allowed to die out, damper closed, and bars and furnace gradually cooled off. This really is the method used for making blister steel, but nevertheless our bridge builders called it annealing steel, and could see nothing improper in it. As I had, however, several times studied the deplorable result produced, I proposed and carried out the following method: The furnace was about 55 feet long and about 6x6 feet in section with grate at one end, and entering doors and chimney at the other; there were a number of fire ports from which the fire and gases belched forth into the furnace at equal distances apart, passing through the hollow walls, again entering other ports in walls, connecting with the chimney. The fire was started and forced until the furnace had reached a very high heat—about yellow. After the fire had been thoroughly banked the ports were all sealed, damper closed, and a direct exit for gases into chimney opened, when the front doors were opened and the iron cars loaded with material to be annealed, rapidly pushed into the furnace which was immediately sealed up again, and the whole allowed to cool. When examination through proper ports showed that furnace and bars had no further heat color, the cars were withdrawn, and material was cooled rapidly in the air; sometimes even rain fell upon it. Tests showed that these bars were all of a very uniform quality, and that in no case was the material injured or weakened, but improved and thoroughly annealed. Heretofore it had been allowed to remain in the furnace until cold, for fear rapid air cooling might injure it. The furnace by the new method turned out the work in one-third the time, and required much less repairing. Now these bars had been allowed to cool slowly until the critical period of carbon change had been passed, and no injury resulted from further very rapid cooling. In case the material was of uniform shape, rapid heating produced no ill effects, which should be carefully guarded against when shapes are very irregular. It may be stated that top chord sections of the shape shown were also annealed by the same method, and that the most careful examination before and after treatment did not develop the slightest change of shape, loosening of rivets, or other possible defect; the length of pieces was, however, increased very slightly, so that the ends required refinishing. Such increase of length was not noticed in annealing eye bars after pin holes had been bored. GUS. C. HENNING.

Wants to Know About Emery Wheels.

Editor American Machinist:

In your issue of May 30th there was an article upon emery wheels by C. H. Norton. It was evidently written by a man who is chock full of information upon that particular subject, and it is time that we had another dose of the same from him. Mr. Norton refers to some questions proposed by him about emery wheels "nearly four years ago," and which have not been answered yet. As I have taken the trouble to hunt these questions up lately in my back numbers of the AMERICAN MACHINIST, it may surprise Mr. Norton, as it did me, to find that they appeared early in 1890, or more than five years ago. The questions are such as to be always timely, and always of interest to live mechanics, and for one, I would be glad if Mr. Norton would get up and answer them himself.

I lately dropped into an establishment where they were making a line of cheap weighing scales for grocers and such use. Their methods were quite crude, and the output corresponded, but they were making some money. The scale beams were punched out of sheet brass, and were then ground upon an emery wheel. The beams were held in the hand without any guide or support, and the wheel was of no particular shape. The edges of the beams were, of course, not sharp and neat, and the job certainly might have been better done. Could not Mr. Norton give us some practical account of some, or more, jobs of actual grinding? TECUMSEH SWIFT.

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Progress of the Metric System.

In England the question of the adoption of the metric system of weights and measures has been stirred up by the report of a committee of the late House of Commons strongly favoring its adoption, and recommending that it be made legal and obligatory after two years.

Of course this has raised quite a commotion, and equally, of course, there is very much of what is pure obstinacy based on nothing more than an innate objection to new things. Nothing but time and education can overcome this sort of opposition, but that which is based upon considerations of real utility as compared with the cost of making the change will not be so easy to overcome. On this phase of the question, however, the committee referred to bring forward some arguments which will probably appeal quite strongly to those practical minds which are influenced by and decide such questions solely upon consideration of what seems, upon the whole, likely to pay best, in dollars and cents.

Not only is it pointed out that all scientists have been forced to adopt the metric system, but it is further shown that English drawings and estimates for machinery are at a very great disadvantage at times, because figured by and based upon a system which has now become obsolete in many of the countries to which they go, and instances are given in which this fact was the chief determining cause that placed orders for machinery elsewhere than in England. This being so, we readily see that if American machinery is to go abroad, this question of the adoption, or at least the use of the metric system will become a live one for American manufacturers.

We have before expressed the opinion, and still think that the metric system considered by itself, and without reference to the difficulties that would attend its general introduction, is as much simpler and better than our present system, as our decimal system of money is simpler and better than the English system of money, which is entirely without regularity of progression from one unit to another. Considered simply by themselves, as though manufacturing were about to be begun, and nothing had yet been done in the way of measuring instruments, gages, and all that class of tools that are made to certain sizes for the purpose of reproducing those sizes—if the two systems could, under such conditions, be placed side by side and considered solely upon their merits—their relative simplicity and usefulness, there would undoubtedly be but one opinion, and the choice would be practically unanimous in favor of the metric system; not because it starts from any particular unit, but because it is purely decimal throughout, is orderly, coherent and symmetrical.

Anyone who has ever given the matter attention, has been impressed with the advantages that would result in simplicity, and in the greater ease of making calculations if our foot were divided into ten instead of twelve inches, and that larger inch again into ten equal parts, each of which would thus be one-hundredth part of a foot. If these small parts were again divided into ten equal parts, each of which would be one-hundredth of an inch, or one-thousandth of a foot, many computations that are now complicated and tedious could be made by a simple shifting of the decimal point from one position to another, and we should be relieved of a great deal of pure drudgery and awkwardness. The metric system offers the same advantages with much more besides, especially when it comes to matters of weight and specific gravity.

The real valid objections to the introduction of the system are based upon the difficulty of making the change in material things—tools, books and other printed matter. We are fully aware that this difficulty is very great indeed, and we are convinced that the expense and bother that will result in shops from an attempt to change from one system to another will prevent the adoption of the metric system until more money is lost, and more bother is caused by not adopting it, than would be by adopting it. In other words, if it comes into use, it will be because it has those elements of vitality that enable it to force itself into use, overcoming the objections and opposition of the merely prejudiced conservatives, and of the utilitarians. There are those who think the metric system has this inherent vitality, and that it will eventually become the universal system of the civilized world. It must be admitted there are some strong evidences that this view is correct, but whether it is or not need not much concern the manufacturer of to-day so far as we can see, for "sufficient unto the day is the evil thereof," and when the occasion and the time arrive that demand a choice in any given case between the two systems—when it becomes a question of which system will best serve the purpose of helping to make successful machinery at a profit, will be time enough to decide; only there should be no blind prejudice in the matter.

It seems certain that international trade in manufactured goods and machinery will increase. The growth of this trade seems likely to prove one of the strongest influences in favor of the adoption of the metric system, and if considerations of utility in connection with England's export business should influence British manufacturers to adopt the system, it is almost certain that any other nation that hoped to export machinery would have to build it by metric measurement. It requires no great stretch of imagination to foresee such an interchange of goods and machinery between different countries as will make some uniform system of measurement and weighing imperatively necessary from purely utilitarian considerations, and if such a uniform system is ever adopted throughout the world, it is almost certain to be the metric system.

Ante Mortem versus Post Mortem Inquests.

We recently called attention to the dangerous practice of transporting, or storing, or using reservoirs charged with gases under high pressures without safety valves. The danger is evident enough from the numerous accidents that have occurred. One of the latest is recorded in the daily papers as follows:

Hudson, Mass., July 21.—Five soda cylinders charged with carbonic acid gas, which were lying in the yard back of Seymore's Block, exploded this afternoon. They were the property of T. F. Mahoney. Pieces were blown to a hight of 100 feet, coming down from 400 to 500 feet from their starting place. The roofs of the Fitchburg Railroad freight depot, and J. P. Russell's grain store were pierced, and several people narrowly escaped being struck. One cylinder, which sailed over the cupola of Houghton's shoe factory, struck between two little girls. Mr. Mahoney was standing in the yard a few feet from the cylinders, but he was uninjured. Nearly all the glass in the rear of Seymore's Block was broken, and the building was otherwise damaged.

If it had happened in this case that someone had been killed, the coroner would have been called to investigate the circumstances, and if anyone had been guilty of criminal negligence, or of positive wrong-doing, to set in motion the machinery for his punishment, or at least to do something toward the prevention of similar accidents from the same cause. This is only a sensible and proper proceeding for the protection of the community. The coroner's function looks to the future rather than to the past. It is possible in many cases to have sufficient evidence of an existing danger without waiting for that danger to accomplish any actual fatality; but nothing in such a case can be done. In the recent explosion of those five cylinders without killing anyone there is as convincing evidence of their deadly power as if each had killed its man. Why, then, when the evidence is indisputable of an existing danger, is it necessary to pile up a long list of fatalities before any action can be taken?

The dangerous gas cylinders are only one instance of a very weak spot in our public practice. Accidents are continually occurring from the action of dangerous causes that have been long and widely known to exist, but which could not even be investigated until actual fatalities gave the warrant. As the matter stands it is not lawful to lock the stable door until after the horse has been stolen. We are often reminded that our foresight is not as good as our "hindsight." It is very certain that it never will be, but the difference would be greatly lessened if we gave our foresight its proper effective exercise.

The Safety Valve is hereby informed that when it reprints from our columns such an article as "Various Causes of Boiler Explosions," photo-engraving our wax cuts and following our copy exactly, crediting the matter to "Proceedings of the Institution of Civil Engineers," without explanation or qualification, it is not conforming to what seems to be the ethics of such matters. The article was condensed for this paper, as we stated at the time, and was not published by us in its original form. We will say nothing of the propriety of thus appropriating our labor and expense in the preparation of the article, we are accustomed to such things; but we insist upon it that the Institution of Civil Engineers has the right to expect that when portions of its proceedings are republished other than in their original form, the fact that abridgements or alterations have been made will be indicated, and that they will not be published under the pretense that they are extracted verbatim and in full from its proceedings.

So far three of the engineer force of the "Ericsson" have died as the result of the accident to which we have previously referred. On the 21st, David Cody, formerly of Worcester, where his father is a machinist, died; Mr. Cody, it is stated, had been graduated from the Worcester High School, and was thirty-two years old. He had married in Jersey City, and leaves a wife and child. The other death was that of "Jack" Strinsky, of Dubuque, who was junior engineer.

It is to be hoped that no lesson that can be taught by the repeated breakdowns of this vessel will remain unlearned. That something is radically wrong with her machinery, or its management, seems quite certain.

We have noted the fact that *The Engineer*, of London, has offered a prize for successful road carriages driven by some form of motor. Now comes the Chicago *Times-Herald* with an offer of a gold medal and $5,000 in cash prizes for the best self-propelled road vehicle, taking part in a race which is to be run between the cities of Milwaukee and Chicago, November 2d. It seems easily within the limits of possibility that the horse will in a few years be banished from streets and roadways, by the machinist.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

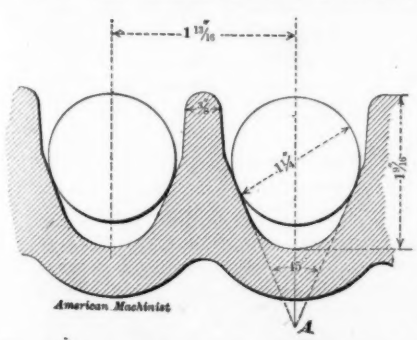
(301) P. E., Newton, N. J., writes: Please explain what is meant by "uncoupling," used in connection with marine engines. *A.*—If a compound or triple-expansion engine drives one shaft, the crank shaft for each cylinder is made separate, and coupled to the next one by an ordinary flange coupling; there is also a coupling between the screw shaft and the engine; hence by "uncoupling" is meant to disconnect any of these couplings, as circumstances may require. 2. Please inform me what material is used for deadening the sound through floors. *A.*—Lay a double floor about 1 inch apart, and fill the space between them with Portland cement.

(302) A. G., Cedar Rapids, Iowa, writes: Please explain the cause for the difference in the distances between the lines of division on the dial of the Westinghouse air-brake gage. For instance, the distances between the numbers 20 and 40 are much greater than between the numbers 100 and 120; the fact of the matter is, there are no two spaces exactly alike. *A.*—The difference is due to the construction of the spring and mechanism in the gage, which, as the pressure increases, will not move the pointer as far at high pressures as at low pressures, consequently the index on the dial is graduated to compensate for the difference in action of the spring and the mechanism.

(303) X. Y. Z., Chicago, Ill., writes: The head of a drop hammer weighs 400 pounds, and falls through a distance of 10 feet, and then strikes a piece of cold iron which is compressed 0.01 inch; what is the striking force of the hammer? *A.*—The stored-up energy of the head in falling through a distance of 10 feet is $400 \times 10 = 4{,}000$ foot-pounds. This energy must be expended before the head can be brought to rest. Now, in bringing this head to rest work is performed which is found by multiplying the distance through which the head travels in coming to rest by the average force exerted, and this product must be equal to the stored-up energy = 4,000 foot-pounds. The distance through which the head travels in coming to rest is 0 01 of an inch = 0.00083 of a foot, hence the average force of the blow will be $\frac{4{,}000}{0.00083} = 4{,}819{,}277$ pounds. This is the theoretical force without making any allowance for the friction which may occur between the head and its guides, and the force expended in compressing the foundation, and even the anvil itself. If this data is known and taken into account in making the above computation, the average force of the blow as found may be much reduced.

(304) C. B. F., Massillon, Ohio, writes: We have had an argument in regard to the slipping of locomotive driving wheels in running over a curve. It is claimed that the outside wheel will travel faster than the inside one, and therefore the inside wheel must slip. Please give your opinion. *A.*—Both drivers make the same number of revolutions in going over the curve, and although the outer driver travels over a greater linear distance it does not follow that the inside driver must slip. In some cases the tread of the tire is tapered, hence the conditions may be such that when the drivers are crowded outwards the outer driver will run on the large diameter of the tread, and the inner driver on the smaller diameter, and thus prevent slipping of either wheel. But this holds true to some extent for engines which have one pair of drivers only. When an engine has two pair of drivers and connected by side rods, then the claim that an engine with tapered wheel treads will run over a curve easier and with less slipping of the wheels than when the tread is straight is a fallacy, and the claim cannot be sustained when sound principles are applied. It is true that when a single cone is rolled over a flat surface it will run in a curve, but if we now take two equal cones and fix their axes rigidly and parallel to each other in a frame, so as to obtain conditions similar to those of parallel axles under an engine, and then roll the cones over a flat surface, the results thus obtained will greatly differ from the results noticed in rolling one of the cones separately. The two cones thus held together will roll in a curve which approaches a straight line. Under these conditions, and the condition of the track, it is difficult to say positively which wheels will slip, both the outer and the inner drivers may slip, and the probabilities are that the inner drivers will slip the most.

(305) G. O., Paris, Canada, writes: Please give me a formula or method for computing the power which a manila rope will transmit. I have looked through a number of papers but have failed to find any suitable formula. The case in hand is as follows:



We wish to transmit 35 horse-power in a direct line 84 feet centers; the driver is 60 inches diameter and will run 150 feet per minute. Will three manila ropes 1¼ inches diameter leave us ample margin? Also give an approved shape of groove. *A.*—The following table gives the horse-power of transmission of manila rope at various speeds; these have been taken from a table given in a pamphlet issued by C. W. Hunt Company, 45 Broadway, New York:

Diameter of Ropes.	Speed of Rope in Feet Per Minute.							
	1500	2000	2500	3000	3500	4000	4500	5000
½	1.45	1 9	2.3	2.7	3.0	3.2	3 4	3.4
⅝	2.3	3 2	3.6	4.2	4.6	5.0	5.3	5 3
¾	3.3	4.3	5 2	5.8	6.7	7.2	7.7	7.7
⅞	4.5	5.9	7 0	8.2	9 1	9.8	10 8	10.7
1	5.8	7.7	9.2	10 7	11 9	12.8	13.6	13.7
1¼	9.2	12.1	14.3	16.8	18 6	20.0	21 2	21 4
1⅜	13.1	17.4	20.7	23 1	26.8	28 8	30 6	30 8
1½	18.0	23 7	28.2	32.8	36.4	39 2	41 5	41 8
2	23.1	30 8	36.8	42 8	47.6	51 2	54.4	54.8

The speed of the rope in your case is $15.7 \times 150 = 2{,}355$ feet per minute; according to the above table the 1¼-inch rope will transmit 14.3 horse-power when running at a speed of 2,500 feet per minute, hence at a speed of 2,355 feet per minute we may expect that it will transmit $\frac{2.355}{2{,}500} \times 14.3 =$ 13.5 horse-power, and the three ropes will transmit $13.5 \times 3 = 40.5$ horse-power, leaving an excess of 5 5 horse-power. The accompanying sketch shows the form of grooves generally adopted; some engineers make the angle at *A* formed by the sides of the groove equal to 60 degrees instead of 45 degrees; however, the latter we believe is the most popular one. It is very important that the sides of these grooves should be carefully polished, as the fibers of the rope rubbing on the metal as it comes from the lathe tools will gradually break fiber by fiber and so give the rope a short life. It is also necessary to carefully avoid all sand and blow holes, as they will cut the rope out with surprising rapidity. The pulleys should not be less than forty times the diameter of the rope for economical wear, and as much larger as it is possible to make them.

(306) E. T., Philadelphia, writes: Please answer the following questions: 1. How to proceed to cut double and triple threaded nuts in the lathe. *A.*—Usually the most practical way of changing the tool from one thread to another in chasing nuts, is to select, if possible, a change wheel for the stud or spindle which has an even number of teeth, and when one thread is finished mark across a tooth of this wheel onto the rim of the intermediate gear with chalk, count half way round the stud gear and mark the opposite tooth, then drop the swing plate enough to separate the gears, turn the lathe until the opposite chalk mark comes into proper position to match the mark on the intermediate, clamp the swing plate again and go ahead. When the thread is triple select, if possible, a gear for the stud which is divisible by three, and thus turn the lathe one-third revolution in changing, instead of one-half. Where for any reason it is inconvenient to pursue this course, then the intermediate gear can be slipped out far enough to disengage the gear on the lead screw, and this gear (and the screw) must then be turned so as to move the tool the right distance, and the intermediate gear slipped back again into engagement. The proper number of teeth to move the wheel must be found in each case by calculation, and a general formula for this might be stated thus; $n = \frac{p \times N}{P}$, where n is the number of teeth the gear must be moved, N the whole number of teeth in the gear, p the pitch of the thread being cut, and P the pitch of the lead screw. Taking the case of a nut which is to have 4 threads per inch double, p, or the distance from the center to center of threads, will be ¼ inch, or .25 inch. If the lead screw have 2 threads per inch, P will then be ½ inch, or .5 inch. Now, if we have a gear on the lead screw with 150 teeth, then $N = 150$, and our formula for this case becomes $n = \frac{.25 \times 150}{.5}$, or $n = 75$. The same method will apply to any case, and the number of threads per inch in nut and lead screw may be used as p and P respectively, if preferred. Of course it will be understood that this formula means simply that multiplying the pitch of the nut by the whole number of teeth in the gear, and dividing this product by the pitch of the lead screw gives the proper number of teeth to move the gear. Another plan which may be followed where there is a compound rest, is to set this rest parallel with the lathe spindle, and move the tool by the feed screw in compound rest. 2. Give rule to ascertain actual diameter and number of threads for steam, gas and water pipes. *A.*—There is no rule for this that we know of. For wrought pipe the Briggs standard thread should be used, and the particulars regarding this thread will be found in our issues of March 19, 1887, and April 9, 1891. The latter article gives all necessary information for making pipe taps, dies, etc. 3. Give name of best book that has rules for thread cutting, with price. *A.*—We cannot undertake to designate the *best* book on any subject. You must read over book notices and endeavor to keep informed in such matters. 4. Do the formulæ in Brown & Sharpe's catalog apply to involute as well as epicycloidal teeth of gears? *A.*—Yes. 5. What is the standard hight and width of a carpenters' or machinists' work bench, and of what material and thickness is the top in general practice? *A.*—The standard hight of machine shop work benches is 2 feet 10 inches, and we believe carpenters' benches are about the same. The top may be of any hard wood, oak being one of the best. The plank in front should be not less than 2 inches thick, and 3 inches is better. At the back of the bench the covering may be lighter. Planed cast-iron plates are now being used to some extent for tops of machinists' benches. 6. Suppose I have an iron bolt 12 inches diameter, how shall I proceed to ascertain the standard number of threads for the same? *A.*—We are not certain about this, and do not know that there is a standard for such bolts. When a bolt is so large as this, it is much more important to make the pitch adapted to the conditions of the job, than that it should be standard. The interchangeable feature is not important in the case of 12-inch bolts and nuts.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 632.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Marine Iron Works, Chicago (new catalog).

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Wanted—Machinery to build: special, steam, mill, hydraulic. F.C. & A. E. Rowland, New Haven, Conn.

I make Machinery Name Plates, Brass or Aluminum Designs Furnished. Write for prices. Twining Campbell, Aluminum Founder, Paterson, N. J.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

American packing rings are in touch with the cylinder. New circular about rings and pistons. J. H. Dunbar, Youngstown, O.

Hand-Book of Calculations (10th Ed.) for Engineers and Machinists, by Hawkins. Price $2.50, catalog free. Theo. Audel & Co, 91 Liberty street, N. Y.

Machine work solicited; complete equipment modern machine tools; patternmaking, designing, experimental work; tech. assistance if required; best facilities & very reasonable prices. P. Pryibil, 512-524 West 41st St., N. Y. See page 686.

Just Published—"The Modern Machinist," by John T. Usher. Price, $2.50. Each of its 257 illustrations represents a new device in machine shop practice; a new book from cover to cover; agents wanted in every machine shop; send for special illustrated circular, Norman W. Henley & Co., 132 Nassau street, New York.

A Machine Shop Operated While Being Moved.

On account of the raising of the tracks of the Providence division of the N. Y., N. H. & H. R. R. Co., between West Chester Park and Forest Hills Station, in Boston, Mass., the Sturtevant Blower Works, at Jamaica Plain Station, had to arrange for moving one of their largest factory buildings. This building is 350 feet long by 50 wide; about one-half the length is three stories high, the other half two stories high. The three story part of the building had to be moved a little over 300 feet to the south, and then 50 feet to the east. The other half of the building is to be moved to the east 50 feet, or its width; a small portion only of the center, where the power plant is now located, will be torn down, and the new power plant erected.

An interesting feature of this work is the fact that regular work in the three-story building was carried out during the entire time while the building was being moved, except on the lower floor; which being laid on the ground, necessitated removing all the tools from that floor. The second story, in which a part of the smaller steel plate blowers are made and tested, and the upper story, in which blast wheels and other blower appurtenances are built, were kept running all the time during the moving process.

An electric motor of about 20 horse-power was located on the second floor of the building, and belted to the main line of shaft. On this floor was erected a reel of wire, one end being connected to the motor and the other end to the generator in the engine room; and, as the building was moved away from its original place and from the power plant, the wire was unreeled, and in this way an electric current was furnished for driving the motor at all times during the moving of the building.

This building is 175 feet long, 50 feet wide and three stories high, with brick walls 20 inches thick at the first floor, and 16 inches thick at the second floor, with a heavily timbered monitor roof.

None of the tools, nor stock or work in process was removed from the two upper floors. It is believed that this building is one of the largest and heaviest buildings ever moved in New England.

The moving was accomplished in the ordinary way by means of ten horses connected with capstans, and ten sets of ropes and blocks. It was at first intended to move it with rods and turnbuckles, but it was found that even after they had been made large enough to withstand the strain the process was too slow. The progress with the turnbuckles was only 13 feet in 10 hours, but with the final arrangement the best progress was something like 60 feet in one day. Before moving the building, it was tied together lengthwise and crosswise by heavy iron rods, and had blockings and rolls placed under the side and end walls, and under the center posts. The whole building was moved without any injury, although the last part of its journey of 200 feet was over filled ground. The other end of this building will be moved in a similar manner.

It is believed that this is the first instance of any building being moved, and the work continued in it at all times, and it is particularly interesting from the fact that the building is so large and heavy, and has been successfully moved and that the company has been able to continue its work, which would not have been possible, except by means of electricity.

When the plant of the Sturtevant Blower Works is fully re-arranged, the entire length of their buildings will be about 900 feet along the railroad track, with a width of about 200 feet, covering a floor space of about seven and one-half acres.

As this company is very busy at the present time, it was important that the moving should be accomplished with the least possible interference with the work.

Facts for Young Engineers—III.

BY W. H. WAKEMAN.

PRESSURE ON CRANK PIN—ADJUSTING VALVES.

If we know the total pressure on a crank pin, how shall we determine the pressure per square inch? Shall we take one-half of the circumference and multiply it by the length, or shall we multiply the diameter by the length? We are told that all lubrication is crushed out when the pressure per square inch exceeds a certain limit, and how are we to determine when this limit is reached? The boxes do not, as a rule, bear on one-half of the circumference of the pin, but for convenience sake let us suppose that they do. The oil is between every square inch of such bearing on the pin and corresponding bearing of the box, and as we are calculating on the surfaces which are to be kept apart by the oil, is there any reason why all of this surface should not be taken into consideration? When we estimate the bursting pressure of a steam boiler, we divide by the diameter of it in the latter part of the calculation, because the force tending to rupture it acts in straight lines, as it were, and does not follow the circumference, but is this a parallel case to the crank-pin problem? We think that there is some chance for study and investigation along this line.

The young engineer when asked if the eccentric always leads the crank, is much

inclined to answer in the affirmative, but he should remember that this is not always the case, for it depends on the design of the valve, and the form of connection between it and the eccentric.

If steam is admitted past the outside edge of the valve, and the connection is direct, then the eccentric will lead the crank, but if steam is admitted past the inner edge of the valve, with the same form of connection, the crank must lead the eccentric, and, furthermore, if we take the common slide valve and put a rocker arm which is hung in the middle, or with the valve rod connected to one end, and the eccentric rod to the other, between it and the eccentric, then the crank must lead the eccentric, and the direction in which the engine runs does not affect the truth of the above statements. Such questions are frequently asked a candidate for admission to a society of engineers, or when he applies for a license in cities where such documents are required, and as they are regarded as test questions, they should be well understood.

If we take an indicator diagram from our engine, and find that all of the movements are late, we may remedy the defect by moving the eccentric ahead on the shaft, for this will make them all take place earlier, but if we have a Corliss engine, or any other with a valve gear that works on a similar principle, and wish to open the exhaust valves earlier in the stroke, we can accomplish this by shortening the connections between the valves and the wrist plate, but at the same time we must remember that this will result in less compression, which may not be desired. If we seek to secure early release by moving the eccentric ahead, we shall get more compression, which may or may not be wanted, but the greatest objection to this is that we shorten the range of cut-off, which in the case of a heavily loaded engine is not desirable. If we have but one eccentric, then we must compromise between the two objections, but if our steam valves are operated by one eccentric, and our exhaust valves by another, then we can secure the best results, and this is why some of the Corliss engines are so made at the present day.

These engines cannot be so readily handled as where there is but one wrist plate and one eccentric, for if the steam wrist plate is disconnected, and the motion of the valves reversed in stopping or starting, the result is not entirely satisfactory, because if the exhaust wrist plate is still connected, the exhaust valves will be open when they should be closed, and closed when they should be open. Some special device to overcome this objection should be attached to large engines.

Steam Yacht "Wapiti."

Yachting on the great lakes has of late years become a favorite pastime, not only with the people residing in the vicinity, but also with many others who often bring their craft up the St. Lawrence River and through the Welland Canal for a summer cruise on the lakes.

The lively interest taken by the members of the yachting circle in these craft, and the admiration of and the desire of having up-to-date yachts, have awakened the lake shipbuilders to the importance of keeping abreast of the times, and they are now paying special attention to yacht construction. The energy displayed by the shipbuilders in the lines of improved designs and constructions has resulted in bringing out yachts which, from the standpoint of safety, comfort, elegance and workmanship, compare very favorably with the best work of builders along the coast, and in the vicinity of the Atlantic Ocean.

With this we give illustrations of the steam yacht "Wapiti," of recent construction, which is said to be one of the handsomest craft on the great lakes. She was built by F. W. Wheeler & Co., West Bay City, Mich., for Isaac Bearinger, of Saginaw, Mich., and replaces his old yacht of the same name. Fig. 1 is a side elevation, front elevation, and plan of the engine, which is of the vertical, inverted-cylinder, direct-acting, triple-expansion type; diameter of high-pressure cylinder is 9 inches; intermediate cylinder, 14 inches; low-pressure cylinder, 23 inches; stroke, 14 inches. Propeller ("Trout" wheel), 4 feet 6 inches diameter, and 6 feet 6 inches pitch.

In order to take up fore and aft as little space as possible, the valves, which are all of the piston type, were put on the side of the cylinders, as indicated in the plan of the engine, and operated by the Marshal radial valve gear. The cylinders are covered with magnesia, and lagged with polished mahogany. The bed plate is of cast-iron of the girder type; it has five main journals, and a thrust bearing of the horseshoe type, with two collars cast on.

The crank shaft is forged solid, with cranks at 120 degrees apart in the following order: I. P., H. P., and L. P. All working parts are made as light as possible, with all the rods and bolts of machinery steel. All main journals and crank-pin brasses are lined with anti-friction metal. The engine is designed for a piston speed of 950 feet per minute.

The surface condenser was made by Dean Bros., of Indianapolis, Ind.; it has combined air and circulating pumps; diameter of air pump, 9 inches; circulating pump, 9 inches; and steam cylinder, 7 inches; stroke of all, 10 inches. The brass tubes in condenser are $\frac{5}{8}$ inch diameter and 6 feet long, giving a cooling surface of 385 square feet.

Steam is supplied by a Roberts' safety water-tube boiler, 8 feet 8 inches long, 8 feet 5 inches wide, and 8 feet 4 inches deep, with grates for burning anthracite coal. The allowable steam pressure is 300 pounds per square inch, and at this pressure, with the engine running at the rate of 350 revolutions per minute, a speed of 16 miles per hour is obtained.

A special feature in connection with the machinery is a patent universal roller thrust bearing, made by M. Schmaltz, of West Bay City, Mich. This bearing consists of eight conical rollers running between two cast-steel disks. All parts of this bearing are well adjusted, and the friction is reduced to a minimum, thereby increasing the useful work of the engine.

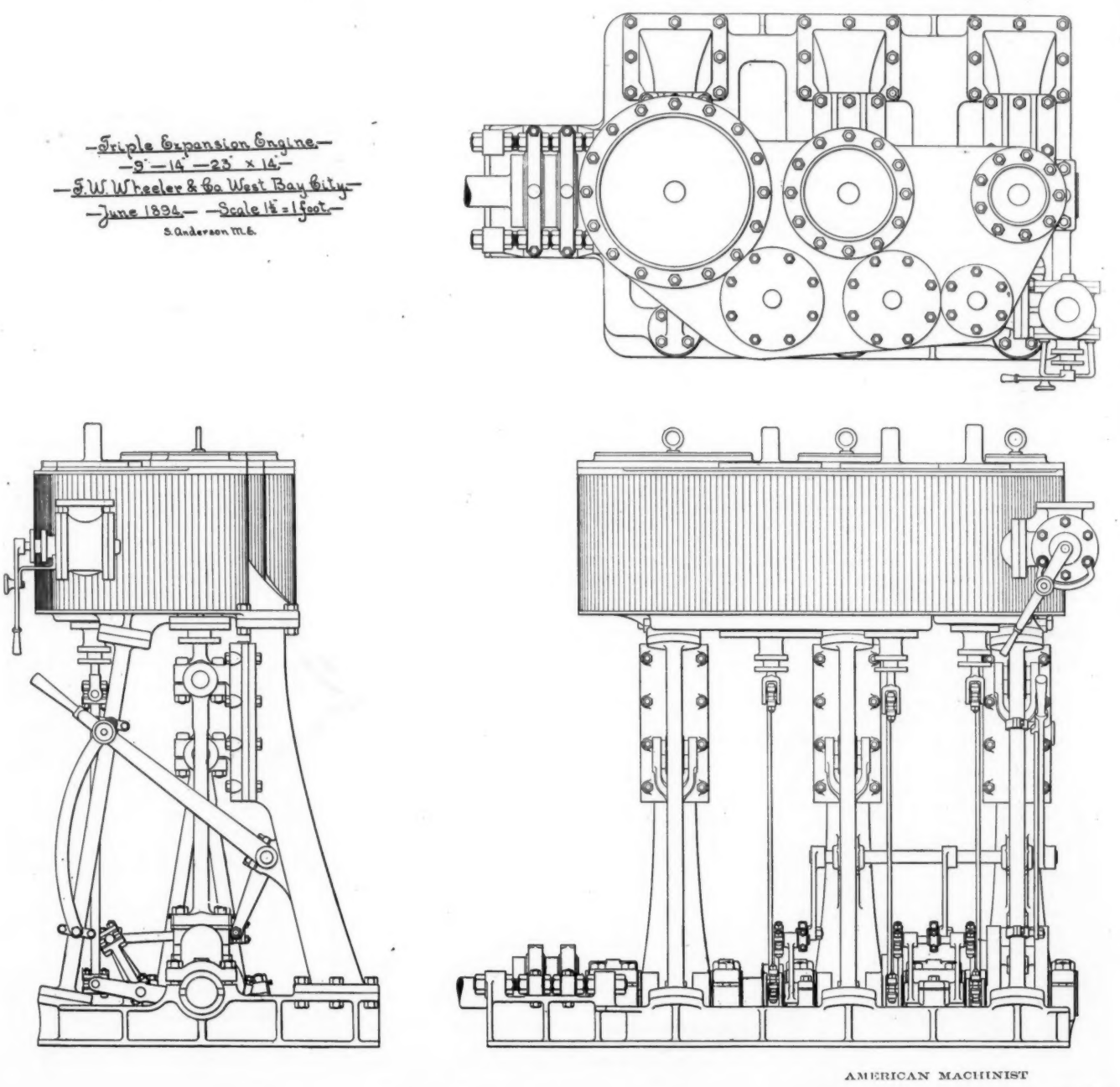
The "Wapiti" is a steel two-masted schooner-rigged yacht of the following dimensions: Length over all, 106 feet 6 inches; length on water line, 98 feet; beam molded, 14 feet 4 inches; depth molded, 7 feet.

The hull is built of mild steel, having a tensile strength of 55,000 to 60,000 pounds per square inch. The weight of shell plating is from 10 to 12½ pounds per square foot. The frames are placed at 17 inches from center to center, and are of steel 2½x2½ inches angle, and weighing 5 pounds per foot. The floor plates are 15 inches deep, and weigh 10 pounds per square foot. There is a reverse angle on top of floors 2½x2½ inches, 4 pounds per foot. A continuous center keelson runs the entire length of the vessel; it is made of two angles, 4x3 inches, 12 pounds per foot, riveted back to back, and strongly connected to reverse frames. There are also three keelsons running the full length of the ship, made of 3x3 inches, 8 pounds per foot angles riveted back to back.

The bulwarks are of steel, and paneled inside with mahogany. There is a full hight deck house forward, with a low trunk cabin aft. The ventilators are of brass, and polished. All the railings are of brass pipe, nickel-plated, and form a pleasing contrast with the dark wood of the cabins. All the woodwork above deck, including cabins, bulwarks, and seat, is of mahogany, with the exception of the rail, plank sheer and house coamings, which are of teak. The interior of forward deck house is finished in quarter-sawed white oak panels, and the after cabin is finished in white mahogany. The ceilings in the cabins are all hand-painted in oil, on canvas; the designs are artistic and appropriate.

The yacht is fitted with a steam capstan of the American Ship Windlass Co.'s design. The steering wheel and binnacle, located abaft the foremast on top of the forward cabin, are of polished brass. There are two lifeboats of polished cedar on top of the trunk cabin amidship.

The owner, Mr. Bearinger, who is said to be an enthusiastic yachtsman, had many of his ideas incorporated into the design and construction, so as to obtain a yacht which shall be satisfactory in regard to safety, elegance, speed and comfort.

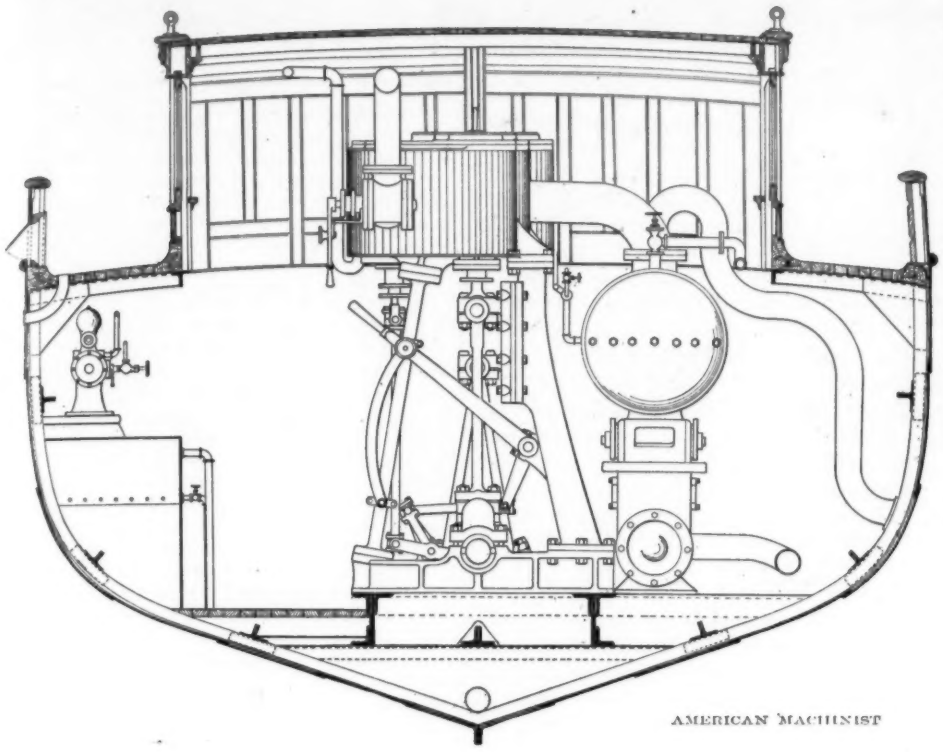

Triple Expansion Engine
9 — 14 — 23 x 14
F. W. Wheeler & Co. West Bay City.
June 1894. Scale 1½ = 1 foot.
S. Anderson M.E.
AMERICAN MACHINIST
Alex. Wills

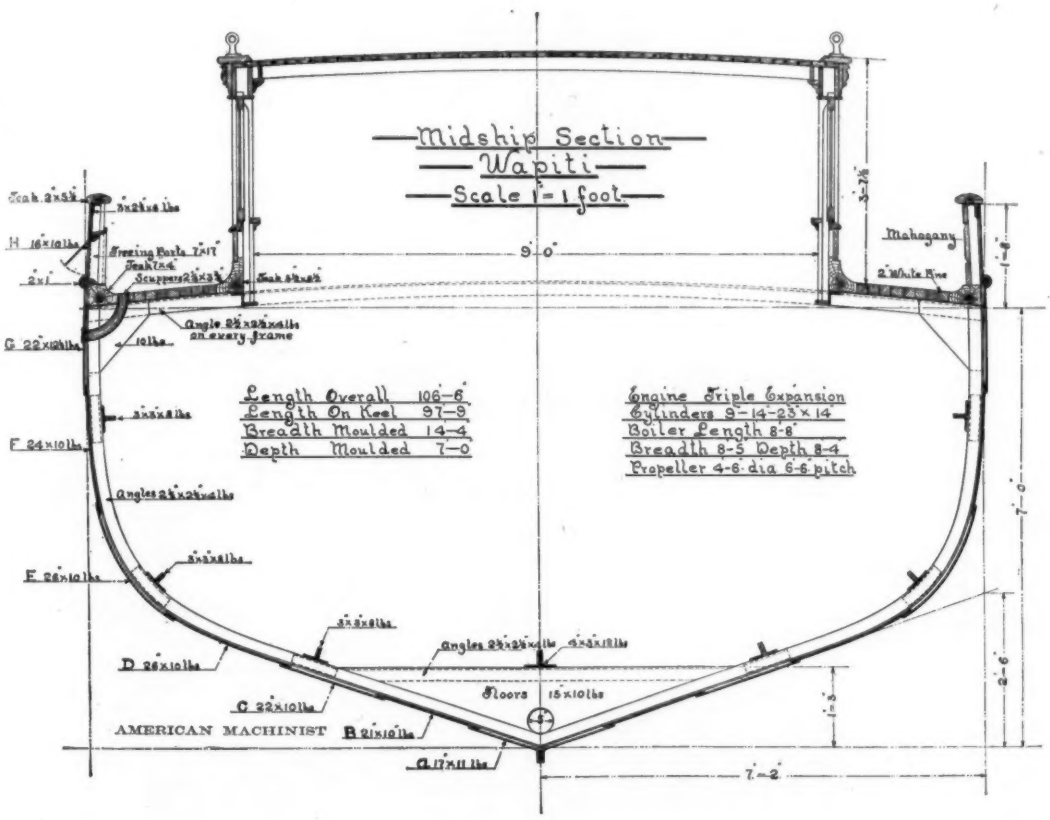
ENGINE OF THE "WAPITI."—FIG. 1.

The Liquid Electric Forge.

The latest, and at first sight one of the greatest of electrical wonders is the liquid electric forge. A good description of this lately appeared in the *Electrical Engineer*. Iron and steel when completely submerged in a liquid, and as an effect of the submersion under suitable conditions, may be quickly heated even up to the melting point, and all the while in the full sight and under the complete control of the operator. The article is really heated by fire, or by the combustion of hydrogen liberated by the electric decomposition of water. The complete submersion of the article has in practice been superseded by an improved arrangement, in which the article is held in contact with the surface of the liquid, and as the hydrogen gas is given off it is ignited directly in contact with the metal to be heated.

A lead plate is connected to the positive wire, and immersed in a conducting solution of dilute sulphuric acid or soda, and the metal to be heated is connected with the negative wire. As exhibited lately at Niag-





A terrible explosion took place in the blacksmith department of the Johnson Steel Plant this morning. Gas accumulated in a forge, owing to an impact of cinders which united with the hot air flashed from the blower, causing an explosion that shook the entire plant. Four men, whose names have not been learned, were badly injured. A large nail was driven into the abdomen of one of the blacksmiths. He cannot recover."

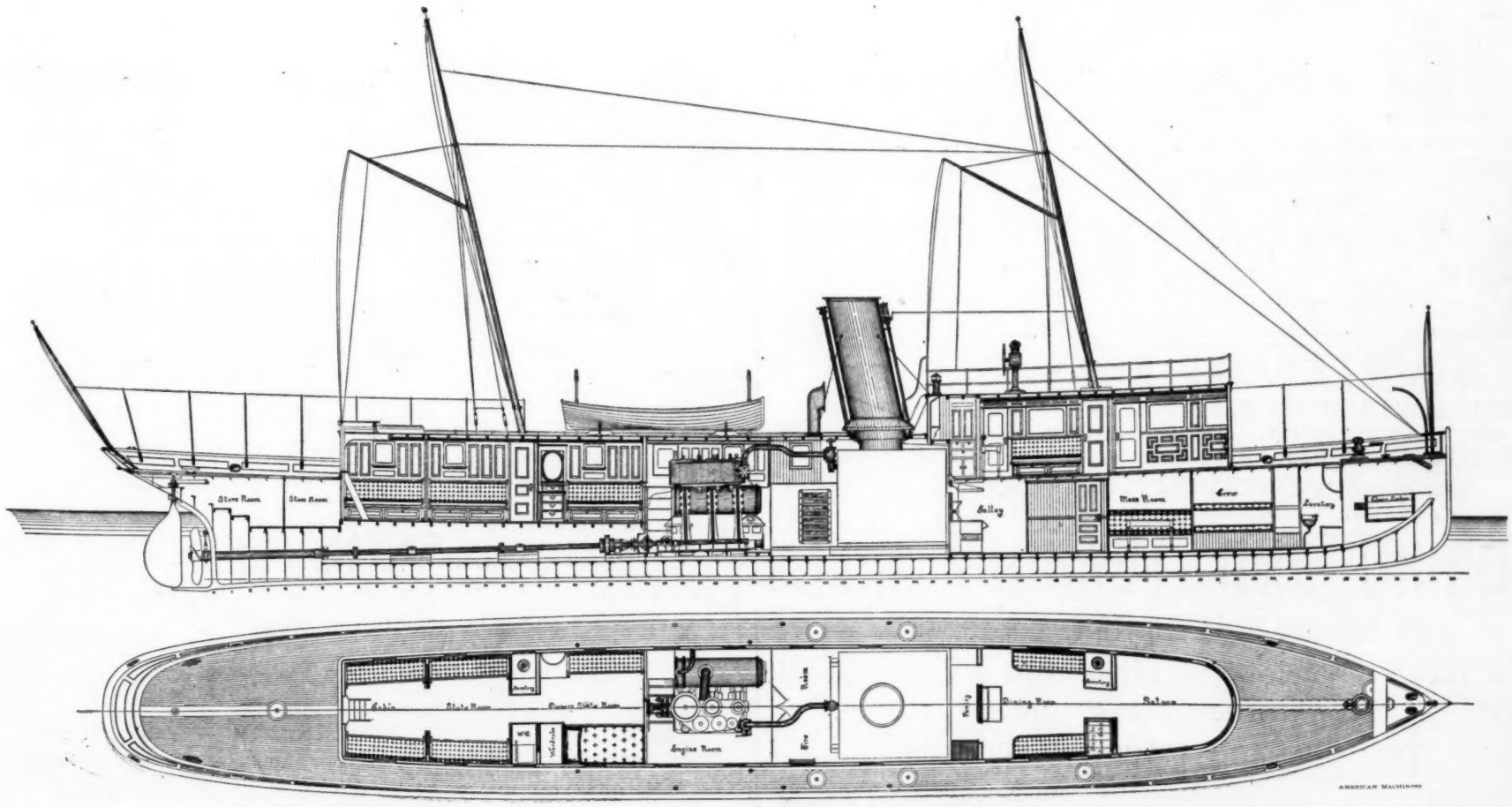
This is evidently the regular, standard, old-fashioned blacksmith shop explosion, and anyone that has never seen one or had to do with it can hardly be said to have "learned the trade." The combination of conditions required to produce the explosion is quite a simple one. Green fires, making gas, a stoppage of the blower from a minute to an hour, tuyere valves open and gas working back into the pipes and mixing with the air, a gentle starting of the blower waking a little flame in the fire, then flash, bang, and the thing is done. We have known several leather bellows and some long lines of windpipe knocked all to pieces, but, fortunately, never saw a man killed in this way. These explosions usually take place when unexpected stoppages of the machinery occur, or sometimes upon starting up after the noon hour. In every case some one is to blame for leaving the wind valve open. One cannot but wonder what the writer of the item thought that he meant when he was writing about "the impact of cinders united with the hot air flashed from the blower."

The Cracked Steam Pipe of the "Aurania."

It is difficult to think of the recent accident to the "Aurania," of the Cunard line, without also thinking of the unfailing Cunard "luck." While in mid-ocean and crowding hard for this port a crack developed in the main steam pipe. The crack might have been a sudden break entailing indescribable horrors. Instead of that, in the most enjoyable of weather the passengers were detained to amuse themselves while the engineers adjusted a patch over the weak spot. The crack occurred in a copper elbow 24 inches in diameter and about 6 feet from flange to flange. The crack, about 18 inches long, ran lengthwise of the pipe and was about midway between the ends of the elbow. The patch was placed upon the inside of the pipe. The actual stoppage was 35 hours, although the voyage was completed under reduced pressure and speed.

At the Baldwin Locomotive Works they have introduced a system of weighing locomotives by which they obtain the weight upon each wheel simultaneously. A number of small scales designed at the works and built by Fairbanks, are mounted upon small truck wheels designed to run upon standard track. Each of these small trucks supports the scales for weighing the weight upon a pair of wheels, and there are enough of them so that all the wheels of a mogul or of a decapod can be weighed separately and at the same time. This system, it is stated, has helped them considerably in some problems connected with weight distribution.

Mr. P. C. Muller, of Apeldoorn, Holland, writes us that he will shortly be disconnected from the firm which he is now in, and will



STEAM YACHT "WAPITI."

give his entire attention to the introduction of American machinery, especially machine tools, in Holland, and her colonies, Belgium, and the west of Germany. Mr. Muller is conversant with the English, German and French languages, which, with his experience in handling machinery, will, of course, greatly help him in the work which he proposes to undertake.

John Richards, in his journal, *Industry*, comments upon Mr. Taylor's paper on "A Piece-rate System," and says: "Our conclusion is that the scheme is an original one of much credit to its author, but is an approach through a more difficult road to the 'contract system,' set forth and explained in an article written by the editor of *Industry* for the AMERICAN MACHINIST, and reprinted in Nos. 78 and 79 of this magazine for January and February of this year."

According to the report of Committee of Awards at Chicago, there has been some mistake in charging that awards have been cheapened by giving one to every exhibitor. It is stated that there were about 250,000 exhibits and 65,422 exhibitors, and that the awards numbered only 23,586. This is said to be a smaller percentage of awards than was made at any former international exhibition.

Stephen Potter Irwin, of Southbridge, Mass., is said to be the oldest cotton manufacturer in New England. He is in his ninety-ninth year, and is as well as most men who reach the age of 75 years.

With the general adoption of high pressures for multiple expansion engines, the result that might have been predicted has not been realized. There has been no increase in boiler explosions, and steam boilers were probably never safer than they are to-day. A new disease, however, certainly has developed, as evidenced in the frequent giving out of steam pipes, valves and connections. It is probably too early to safely generalize upon this subject. The increase of pressure is not alone responsible, higher temperatures have also to be reckoned with. There seems to be a growing distrust of copper under the new conditions.

Steel Canal Boats and Modern Canals.

It would seem to be rather late in the day—but certainly better late than never—to be building our first steel canal boats. The Cleveland Steel Canal Boat Company has just launched the first of a fleet of steel boats which are likely to make a change in the status of the Erie Canal and to give a new impetus to inland navigation. The boats are to have all the improvements that modern invention has devised, and are equally suitable for lake or for canal navigation. They will be capable of traversing our unique system of water ways from the heart of the continent to the sea and back again, giving to all the land and to the world the benefits resulting from cheaper freights and quicker transportation. They should undoubtedly lead us to a recognition of the imperative necessity of enlarging and developing the one defective link in our system of internal navigation. It is unfortunate for the people that "Clinton's Ditch" belongs to a State and not to the nation, for its function is essentially national, and there should be some means of asserting the people's right to the profitable use of it. The ditch and the mule and the wooden boat have done brave service. They created the greatness of the Empire State and they opened the booming Northwest. But they now belong to the days of the sickle and the flail, the spinning-wheel and the hand-loom, the stage coach and the pack saddle. The people have a right to a modern canal for modern craft of a size commensurate with modern ideas and practice, with fewer locks, of quicker operation, and with power traction or propulsion at modern speeds.

A Joggling Machine.

A machine whose use some of our readers could not at once identify under the above title, is finding employment in English ship yards. It is a rather formidable looking machine, a heavy punch or shears, but in place of the shearing blades, or the punches and dies, are a pair of slowly revolving rolls for joggling or kinking the edges of plates for the decks and shells of steel ships. The strokes of plating have heretofore been laid on the raised and sunk or "in and out" principle, the raised plates having packing strips under them equal to the thickness of the sunken strips. The joggling of the plates now dispenses with the packing, and the body of every plate lies snug to the frame or beam, the edges of the alternate plates being raised by this machine to lap neatly over the plates that lie between them. The saving in the weight of packing amounts to forty or fifty tons or more in large ships. This practice has become possible with the improved material now in use. The old iron plates would not have submitted to the joggling.

NEW CATALOGS.

There are three sizes of Standard Catalogs, 9" × 12", 6" × 9" and 4½" × 6". We recommend the 6" × 9" size for machinery catalogs. When they must be larger or smaller, one of the other standard sizes should be adopted if possible.

Naylor Bros., of Peekskill, N. Y., send us a catalog of pulleys, hangers, shafting and all kinds of power transmitting machinery. Illustrations and tables of sizes, telegraph code, etc., are given. The catalog is 4½"x7¼".

The Hogan Boiler Co., Middletown, N. Y., have issued a pamphlet devoted to setting forth the peculiar merits and advantages of their water tube boilers for stationary and marine purposes. It is sent to those interested, and is 7"x10".

The Lane & Bodley Co., of Cincinnati, Ohio, have issued a catalog devoted especially to their "Columbian-Corliss" engine. The catalog is well illustrated and printed, and contains much information of value to engineers generally. It is sent to those interested on application, and is standard size (6"x9").

A. L. Ide & Son, Springfield, Ill., send us a small and elegantly gotten up pamphlet with embossed cover, which is devoted to the illustration and description of the "Ideal" engine. En-

THE DEANE OF HOLYOKE MINING PUMPS.

THE DEANE STEAM PUMP CO.,
HOLYOKE, MASS.
Write for "The Deane Specialties."

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FINE REAMERS
SPIRAL FLUTES.
Also Screw Plates, Taps, Dies and Machinery.
Send for Catalogue.
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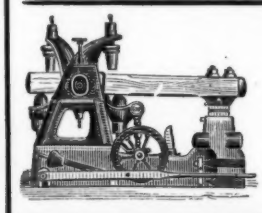

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If you plate, draw, square, taper, swage, collar, spindle, or do any manner of die forging in iron or steel, a Bradley Hammer will soon pay for itself by what it will save over any other similar tool. Helve, Upright and Strap Styles. Send for circulars.
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SEND FOR CATALOGUE E.

THE FINEST STEEL MADE.
Crescent Steel Co.
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PITTSBURGH, PA.
CHICAGO, ILL.
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FOR DIES AND TOOLS DOING VERY HARD WORK.

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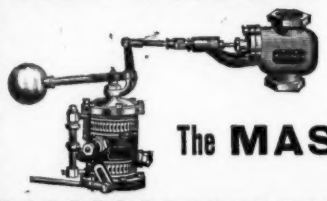

enables you to instantly set or change your pump to any required speed which will be maintained in spite of variation in load or steam pressure.
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Ready Made Iron Gears.
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Modern Locomotive Construction,
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J. G. A. MEYER,
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UNEQUALLED EFFICIENCY, DURABILITY, MINIMUM POWER.
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No. 77, 50 PAGES.
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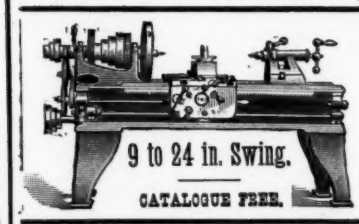

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gravings of various forms of the engine are given, and the book will be found interesting to all who have to do with steam plants. It is 8½"x6".

R. Hoe & Co., New York, issue a special pamphlet devoted to the illustration and description of their improved stop cylinder printing press. This contains, among other things, a letter from Mr. Theodore L. De Vinne, giving his opinion of the respective merits of American and English machinery, with his reasons for same, which will be found interesting.

The Hilles & Jones Co., Wilmington, Del., send us Catalog K, the cover of which is in the style of the most striking, modern, high art, and the contents of which consist of fine illustrations of their various forms of punching, shearing and other heavy sheet metal working machinery. If ¼ inch were trimmed off the length of this catalog, it would be large standard size, 9"x12".

We have received from the Ansonia Brass and Copper Co., Ansonia, Conn., a pamphlet devoted to setting forth the properties and advantages of "Tobin Bronze," which is made by this company. On pages 11 to 13 of this pamphlet are given some figures of tensile, torsional and transverse tests of this bronze, and there are also in other parts of the book a number of interesting testimonials from manufacturers who are using it. The pamphlet is 4"x6", and is sent to any address on application.

MANUFACTURES

The Damascus Steel Co., of Des Moines, Ia., has been organized with a capital of $500,000.

The Missouri Moline Plow Co., of St. Louis, Mo., was recently organized with $100,000 capital.

The Proximity Mfg. Co., of Greensboro, N. C., has been organized with $200,000 capital stock.

A new company has been organized to erect a cotton-mill at Winder, Ga. Jno. S. Smith is interested.

The Revolution Cotton Mill Company has been organized at Greensboro, N. C., with a capital stock of $200,000.

The Mayo Falls Cotton Mill, of Madison, N. C., has been organized by J. H. Fries and others with $300,000 capital.

The Missouri Smelting Co., of St. Louis, Mo., has been incorporated by D. P. Dook and others with a capital of $20,000.

The California Wrench Co., of San Francisco, Cal., has been incorporated by W. A. Boole and W. A. Boole, Jr., with $200,000 capital.

The Cottonwood Box and Lumber Co. has been incorporated at New Orleans, La., with $50,000 capital stock. Its president is R. L. Heflin.

The Ozark Implement Co., of Springfield, Mo., has been organized with $25,000 capital. August Koenigbruck is among those interested.

The Charles R. Sayre Co., of Montrose, Pa., was recently organized for manufacturing hot air furnaces by Charles R. Sayre and Searle McCollum.

The Electric Wire Hanging Insulator Co., of Chicago, Ill., has been incorporated with a capital of $200,000 by Edgar O. Baker and Henry W. Rice.

The Illinois River Bridge Co., of Hennepin, Ill., has been incorporated by W. F. Evans, M. B. Snyder and S. A. Dunham, with $2,500 capital stock.

Speidel & Roeper, Reading, Pa., have added to their establishment a chain shop, in which they will make their own chains for their various kinds of hoisting machinery.

The Susquehanna Rolling Mill, of Columbia, Pa., recently destroyed by fire will be rebuilt shortly. The new structure will be of iron and will be much larger than the old mill.

The Pruyn Milling and Power Company, of Oneonta, N. Y., has been incorporated with a capital of $75,000; the directors are Irving L. Pruyn, Van B. Pruyn and Marquis L. Keyes.

The Little Falls Paper Company has been incorporated with $60,000 capital at Newburg, N. Y., by Amos F. Helden, of Newburg, N. Y.; O. M. George, of Bellow's Falls, N. Y., and J. W. Hurlburt, of Little Falls, N. Y.

J. W. Sullivan, manufacturer of marine and stationary engines, 385 South street, is building large foundry and machine shops at Sing Sing, which will be completed about November 1st. The product will be propeller wheels and heavy machinery castings.

The electric plant used for killing criminals at Sing Sing Prison will be duplicated before the next execution, the plant will be purchased from the General Electric Company. The plant now in use was bought from the Westinghouse people, but had to be shipped first to some port in South America—the Westinghouse people refusing to sell it for the purpose for which it was needed.

The Pittsburgh Reduction Co., Pittsburgh, Pa., are making a polish specially adapted for aluminum, and it is sold under the name of the "Acme Aluminum Polish." They state that it will be found that if aluminum has one-half the attention given to brass, copper, silver, nickel, and similar metals, it will be kept polished very much easier and will be in much brighter condition than any of these metals.

The Williams Manufacturing Co., of Columbus, Ind., is a recently organized stock company capitalized at $25,000. They will engage in the manufacture of bicycles on quite an extensive scale, and have just contracted with The Lodge & Davis Machine Tool Co., of Cincinnati, Ohio, for their complete equipment of bicycle machinery, including hub machines, cone machines, rim drilling machines, milling machines, engine lathes, etc. They are now erecting their buildings, and expect to have the plant in operation inside of 30 days.

The Star City Foundry and Machine Co., of La Fayette, Ind., is a newly organized stock company composed of Messrs. Kreiter, Graves and Southworth who will do a general machine shop business as well as manufacture a few specialties. They are now erecting their buildings, and have placed their order with The Lodge & Davis Machine Tool Co., of Cincinnati, Ohio, for the entire equipment of the plant, including lathes, planers, drills, milling machines, bolt cutters, etc. They have also bought of the Lane & Bodley Co., of Cincinnati, a boiler and engine.

The William A. Harris Steam Engine Co. is working on the following orders: Sessions Foundry Co., Bristol, Conn.—One engine, 12x36-inch pulley, 11 feet diameter, 20½-inch face; one engine, 18x42-inch pulley, 14 feet diameter, 25-inch face; Providence Cotton Mills, Maiden, N. C.—Engine 12x30-inch, to double their present engine of Harris make; Union Cotton Mills, Maiden, N. C.—Engine 16x42-inch, to double their present Harris engine; Heywood Bros. & Co., Gardner, Mass.—Engine 30x60-inch pulley, 22 feet diameter, 42-inch face, second order; M. T. Stevens & Son, for Marland Mills, Andover, Mass.—Engine, 18x42-inch pulley, 14 feet by 25 inches, third order; B. F. Goodrich Co., Akron, Ohio—Engine, 22x42-inch pulley, 15 feet by 25 inches, fourth order; Powhatan Mills, Putnam, Conn.—Pair of engines, 16x42-inch pulley, 15 feet by 41 inches, second order; Taft, Murdock & Co., Caryville, Mass.—Engine, 18x42 inch, no wheel, second order; Steere Worsted Co., Providence, R. I.—Engine, 15x48-inch pulley, 13 feet by 25 inches, second order; H. T. Hayward, Franklin, Mass.—Engine, 16x42-inch pulley, 13 feet by 37 inches, second order; Chelmsford Foundry Co., Boston, Mass.—Engine, 12x30-inch pulley, 10 feet 18½-inch face; J. J. Kenyon, Pawster, Mass.—Engine, 18x48-inch pulley, 13 feet by 25 inches; Slater Woolen Co., Webster, Mass.—Engine, 18x42-inch pulley, 15 feet by 25 inches, fifth order; Easthampton Rubber Thread Co., Easthampton, Mass.—Cross compound condensing engine, 14x42-inch and 26x42-inch pulley, 14 feet by 44 inches, second order; David O. Black, Pawtucket, R. I.—Engine, 10x24-inch pulley, 8 feet by 16½ inches; Jacobo Lemon, City of Mexico, Mexico—Engine, 12x30-inch pulley, 11 feet by 20½ inches.

Machinists' Supplies and Iron.

NEW YORK, August 3, 1895.

Iron—American Pig—We quote standard Northern brands, $14 for No. 1; $13 for No. 2; $12.25 for No. 2 Plain, and $12 for Gray Forge. Southern brands, $13.50 to $14 for No. 1; $13 to $13.25 for No. 2; $12.50 to $12.75 for No. 3; $13 to $13.25 for No. 1 soft; $12.75 to $13 for No. 2 soft; and Foundry No. 4, $12.25 to $12.50

Antimony—The market is firm, and prices remain steady. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¼c. to 8½c; Hallett's, 7.15c. to 7.20c; U. S. French Star, 7.35c.; Japanese, 6.85c. to 7c.

Lard Oil—Prime City we quote at 50c. to 51c.

Copper—The market is very firm at advanced prices of 11¾c. for Lake Copper, and the indications are that the price will advance to 12c. Casting Copper is held at 11c. to 11½c. The demand is good.

Lead—The market is firm and quiet, 3.55c. is asked for New York delivery. It seems that at this figure nothing but a routine business has been effected.

Spelter—The market is firm and prices have advanced considerably, 4c. to 4.05c. is quoted for New York delivery.

Tin—The market is quiet. For early delivery 14.45c. net cash for round lots is asked.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS.

On and after July 4th this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Wanted—Bright, active machinists to canvass for subscription to AMERICAN MACHINIST, liberal commission. Address, with refs., Subscription Dep't, AMERICAN MACHINIST, 203 Broadway, N. Y.

Draftsman wants position, shop experience, best ref's. Address Robert Palm, Bainbridge, N. Y.

First-class patternmaker, American, wants position, competent to take charge. Address Box 74, AMERICAN MACHINIST.

Wanted—Steady patternmaker. Reliable man. State experience and wages expected. Address "Castings," care AMERICAN MACHINIST.

Wanted—Situation as general foreman or superintendent of high speed engine shop; at present supt. of shop. "D. A.," care AM. MACHINIST.

Mechanical draftsman with technical education, shop and office experience, wants position. Address Box 68, AMERICAN MACHINIST.

Sixteen years experience as draftsman, tool maker and foreman, wants situation on special machinery, investigate. Lock Box 160, De Kalb, Ill.

Wanted, immediately, first-class machinists for vise and lathe work. Apply to Fairbanks, Morse & Co., Beloit, Wis.

Mech. supt. of general foundry, machine and boiler works, power transmission, factory construction, steam heating, modern methods; ample refs., wants pos. Mechanical Supt., AM. MACH.

Superintendent open for engagement August 1st; well up in modern methods, machinery, tools, jigs, etc.; interchangeable work at minimum cost. Address Box 65, AMERICAN MACHINIST.

An all-around machinist, 15 years' experience, desires a permanent engagement. Job shop in or near New York preferred. Address Box 72, AMERICAN MACHINIST.

Patternmaker and draftsman wants position, South preferred; large experience in agricultural machinery and special machinery for modern methods. Address Box 63, AMERICAN MACHINIST.

Wanted—Position in drafting room or shop by man of long experience in designing and building special machines, tools and fixtures; has had charge of shop. Box 79, AMERICAN MACHINIST.

Wanted—Situation, superintendent or foreman in or near York City, by competent wood and metal patternmaker; capable as machinist and draftsman; steady and reliable; 13 years' references as foreman. Box 61, AMERICAN MACHINIST.

(*Continued on Page* 634.)

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LARGE RANGE OF WORK—LOW PRICE.

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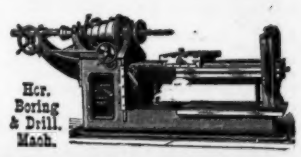
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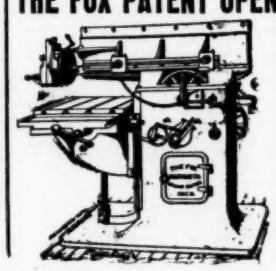

No springing of ram. No overhanging table. Quick Return. Stroke Under Perfect Control. Can be Instantly Adjusted 1-16 in. or 24 in. No Screws to Monkey with. Powerful, Quick, Accurate. Write for circular.
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"BOREAS" SELF-HARDENING.
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AGGREGATING IN CAPACITY
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HORSE POWER
ARE NOW IN USE.
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Wanted—As instructor in machine shop practice, a young man thoroughly up in modern shop methods, with experience in responsible charge of work, and a capable draftsman. Address with references, stating salary expected, Box 232, AM. MACHINIST.

Expert machine designer, experienced on stamping and forging machinery and tools, and familiar with engine and boiler work, desires a position. Practical machinist with technical education and extensive experience; age 37. Box 73, AM. MACH.

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Position wanted as foreman master mechanic, or any capacity requiring the services of a first-class mechanic; experienced in marine and stationary engine building and rolling-mill work, and very good draftsman. Box 64, AMERICAN MACHINIST.

Wanted—A practical man with some capital, a knowledge of drawing and mining machinery, to take charge of a foundry and machine shop in a mining district. Address, giving references and experience to Box 70, AMERICAN MACHINIST.

Wanted—Position by a competent machinist and toolmaker, who understands modern methods and drafting, as foreman in machine shop, or chief toolmaker in large plant; best of references. P. F. S., 42 Cristel St., Chicago, Ill.

A man aged 29, 14 years' experience as machinist, draftsman and designer with leading firms, wants position in charge of office, or as mechanical superintendent of factory; write for references. Box 71, AMERICAN MACHINIST.

Wanted—Position as foreman or superintendent, used to designing tools for close interchangeable work to reduce cost; have had charge of light and heavy work; had experience building dynamos. Address A. T., AMERICAN MACHINIST.

Wanted—Foundry foreman in foundry near New York City, capable of handling 50 molders on ordinary machinery castings. Must be able to rig up patterns for economical production. Address, stating past experience, age, and wages expected, Green Sand, Box 75, care AMERICAN MACHINIST.

Wanted—By steady, sober, experienced machinist and jobbing molder, position where molder is required to understand melting and the management of small shop in city or country. Address F. C. N., AMERICAN MACHINIST.

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Wanted—Foundry foreman in a good Western city; must be accustomed to light work; acquainted with the latest and best foundry methods, also understand mixing and melting brass, and a man of good executive ability. Good steady job, state nationality, age and experience; give reference, and state salary expected. Address "Q.," AMERICAN MACHINIST.

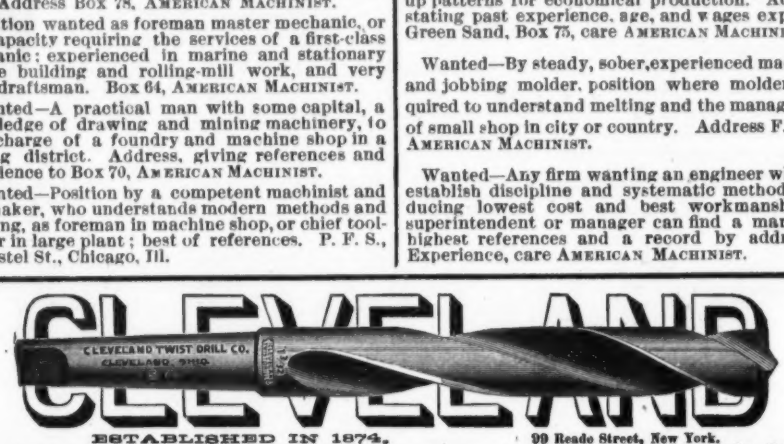
✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M. York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

(*Continued on Page* 635.)



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Easy way to make good living. Catalogue for 6 cents in stamps. FULL OUTFIT. Bellows, Blowpipe, Vise, Spoke Threader, Solder, Borax, ready to go to work. FRASSE CO., 17 Warren St., NEW YORK.

NEW AND SECOND-HAND MACHINERY.

ENGINE LATHES.

13 in. x 6 ft Blaisdell.
14 " x 6 " Flather.
15 " x 8 " Standard.
16 " x 6 " Blaisdell.
16 " x 7 " Pratt & Whitney.
16 " x 8 " Putnam, A1.
16 " x 8 " Fifield with Ck.
18 " x 8 " Fitchburg.
18 " x 8 " Flather.
20 " x 8 " Putnam, A1.
20 " x 10 " Harrington.
24 " x 12 " New Haven.
24 " x 22 " Perkins
28 " x 16 " Fay & Scott.
32 " x 16 " Waterman.
32 " x 30 " Improved style.
72 " x 20 " Union.

DRILLS.

Barnes Friction Drill.
Sensitive Drill, Improved.
Prentice 26 in. complete with Friction Pulleys for tapping
Blaisdell 28 in. Bk. Geared.
Improved 28 in. complete.
Radials 3, 4 and 5 ft.

CYLINDER BORING MACHINE.

Bement's for Cylinders to 36 in.

PLANERS.

22 in. x 5 ft. Putnam.
22 " x 5 " Pease.
24 " x 5 " New Haven.
24 " x 6 " Lathe & Morse.
24 " x 6 " Rochester.
28 " x 5 " Gaze.
30 " x 10 " Harrington.
48 " x10 " Gray, 2 Heads, A1.

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10 in. Stroke, Crank, Prentiss
15 " " " Gould & E.
16 " " " Prentiss.
18 " " Geared, A1.
26 " " " "
14 " " Trav. Head, with centers, circular feed, Fitch'g.

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P. & W. No. 2 Wire Feed.
Brown & Sharpe No. 5, complete.

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Garvin No. 3 Power Feed.
Lincoln Pattern with Vise.
"Universal" Latest, good as new.
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10 ft. Latest Improved.
8 " Extra Heavy.
7½ " Standard Size.

Gray Planers "NEW," 22, 24, 30 and 36 in.
Kempsmith Millers, Universal and Plain.
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Fitchburg Lathes, 14 to 72 in. Swing.

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SUCCESSOR TO E. P. BULLARD'S N. Y. Mach'y Warerooms.

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Second-Hand Machinery.

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2 10 in. x 5 ft. Foot & Power.
2 11 in. x 5 ft. Power only.
1 15 in. x 6 ft. Dustin.
1 16 in. x 8 ft. Flather.
2 18 in. x 8 ft. Flather & Prentice.
3 18 in. x 8 ft. Lodge & Davis.
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1 27 in. x 10 ft Dustin.
1 28 in. x 12 ft. Blaisdell.
2 30 in. x 14 ft. Lincoln.
1 32 in. x 13 ft. Bement Triple Geared.
1 22 in. x 10 ft. Niles.
1 24 in. x 10 ft. Niles.
1 79 in. Driving Wheel, Bement.
1 48 in. x 18 ft Gay & Silver.

PLANERS.

3 48 in. x 52 in. x 6 ft. Pond, two heads.
1 48 in. x 32 in. x 8 ft. Pond, two heads.
3 24 in. x 24 in. x 6 ft. W & L., one head.
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1 32 in. x 32 in. x 10 ft. W. & L.
1 38 in. x 38 in. x 10 ft. Aldrich.
1 32 in. x 10 ft. Open Side.
1 60 in. x 60 in. x 22 ft. Hepworth

DRILLS.

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2 25 in. " & P. F., Snyder.
1 34 in. " " Harris.
2 No. 1½ Niles Radial.
2 Suspension Drills.

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1 No. 1 B. & Sharpe.
2 No. 13 Garvin.
1 No. 15 "
1 No. 2 " Hand, and others.

SHAPERS.

9 in., 12 in., 13 in., 15 in., 20 in.

MISCELLANEOUS.

1 18 in. P. & W. Screw Machine.
1 20 in. x 6 ft. Flather "
2 Horiz. B. & D. Machines.
1 Cylinder Borer, P. & A.
1 30 in. Motor Gear Lathe
1 Double Punch and Shear.
1 30 in. Pulley Lathe.
1 Hydraulic Riveter.
2 Bolt Cutters.
1 Nut Tapper.
1 20 in. Pattern Lathe.

Also large stock of other tools. Send for List.

Eastern Branch Niles Tool Works Co.,
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12 in. x 5 ft. Ballou Patent.
16 in. x 6 ft Ames Mfg. Co.
16 in. x 8 ft. Perkins, Taper.
18 in. x 10 ft. Blaisdell.
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37 in. x 14 ft. Maker Unknown.

PLANERS.

12 in. x 30 in. Wilkinson for Hand or Power.
22 in. x 22 in. x 4 ft. L. W. Pond.
24 in. x 24 in. x 5 ft. Putnam.
24 in. x 24 in. x 6 ft. Chamberlin.
24 in. x 24 in. x 6 ft. Whitcomb.

SHAPERS.

10 in. Pratt & Whitney.
12 in. Juengst, Crank.
15 in. Juengst Friction.
10 in. Wood and Light Traverse Head.
21 in. Smith & Silk, Shifting Belt.
20 in. Gould & Eberhardt.
24 in. Hendey, Friction.

HAND LATHES.

2 10 in. x 41 in. Garvin.
1 12 in. x 4 ft. L. W. Pond.
1 12 in. x 6 ft. Wright.
1 12 in x 5 ft. Back Geared.
1 20 in. x 8 ft. Back Geared.

MISCELLANEOUS TOOLS.

24 in. Barnes Water Tool Grinder.
Garvin Profiler, one spindle.
No. 2 National Bolt Cutter.
60 in. Lincoln Gear Cutter.
26 in. Pulley Lathe.
50 in. Pulley Lathe.
5 in. Cutting-off Machine.
No. 2 Springfield Tool Grinder.
No. 1 Garvin Screw Machine.
No. 1 Brown & Sharpe Screw Machine.
No. 2 Brown & S. Universal Grinder.
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250 lb. Gould & E. Drop Press.
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No. 2 Garvin Wire Spring Coiler.

Also, a large number of other machines. Write for complete list, description and prices.

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SECOND-HAND MACHINERY.

Gould & Eberhardt Automatic Gear Cutter.
Pratt & Whitney 26" Chucking Lathe.
18"x5' Pratt & Whitney Lathe, taper attachment.
Niles Horizontal Boring Machine, 4" bar.
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60" Triple Geared Engine Lathe, 1894 Pattern, used Three Months, a modern tool in fine order.

Will sell the above tools at low prices. Send for new catalogue of Bicycle Machinery.

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BEFORE REMOVAL.

At Phœnix Iron Works, Trenton, N. J.

15 in. x 6 ft. Engine Lathe.
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29 " x 13¾ " " "
26 " x 20 " " "
29 " x 12 " " "
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52 in. x 20 ft. Engine Lathe.
19-36 and 50 in. Drills.
Portable Drill.
36 in. x 14 ft. Planer.
12 in. Shaper Traverse Head.
Gear Cutter, 54 in.
Milling Machine.

10 ft.-16 ft. Vertical Boring and Turning Mill, Cranes, Blower, Boiler Rolls, Punch and Shear, etc.

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The Dayton Swaging Machine is the best for reducing and pointing wire and tubing. If interested address the manufacturers,

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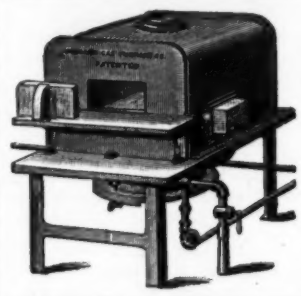

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IN FIRST-CLASS CONDITION.

16 in. F. B. Miles Slotting Machine.
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Two (2) 5 ft. Universal Radial Drills.
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40 in. Bement Vertical Drilling Machine.
24 in. Pratt & Whitney Vertical Drilling Machine.

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28 in. x 24 in. x 7 ft. New Haven Planer. New.
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6 in Boynton Hand Shaper. " " "
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Lot 6¼ in. and 7¼ in. Hammered Steel Shafting.
Bearings, Friction Clutch Pulleys, etc., less than half value.

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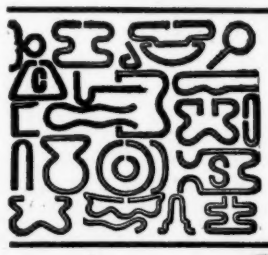

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For all Anti-Friction Purposes.

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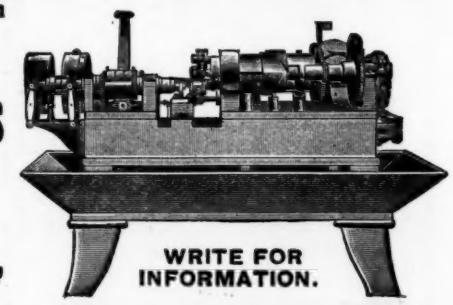
CLEVELAND, OHIO.



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Pat's obt'd; no atty's fee until allowed; exp't service. Thurman & Silvius, mech. engs., Ind'polis, Ind.

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Wanted—An Idea. Who can think of some simple thing to patent? Protect your ideas; they may bring you wealth. Write John Wedderburn & Co., Patent Attorneys, Washington, D. C., for their $1,800 prize offer.

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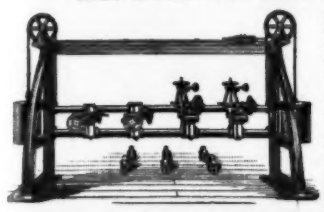

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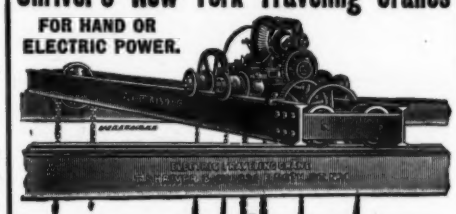

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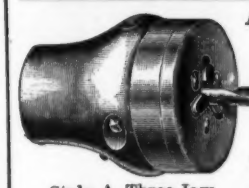

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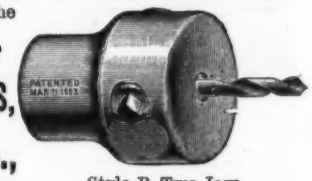

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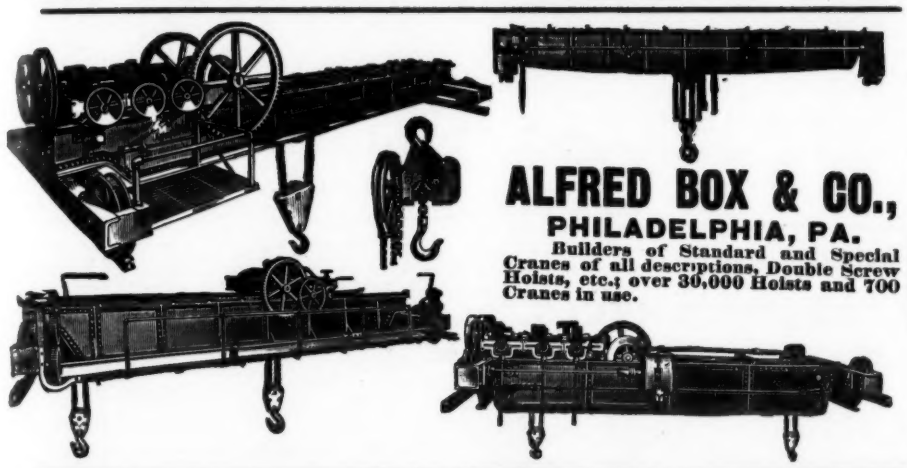

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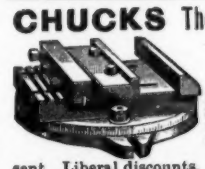

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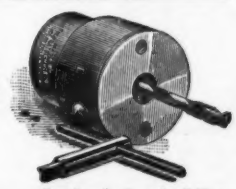

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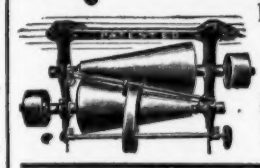

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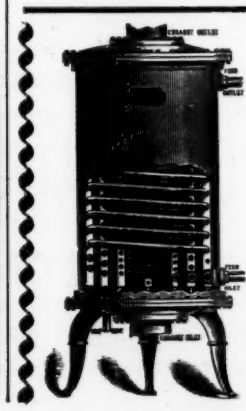

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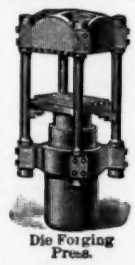

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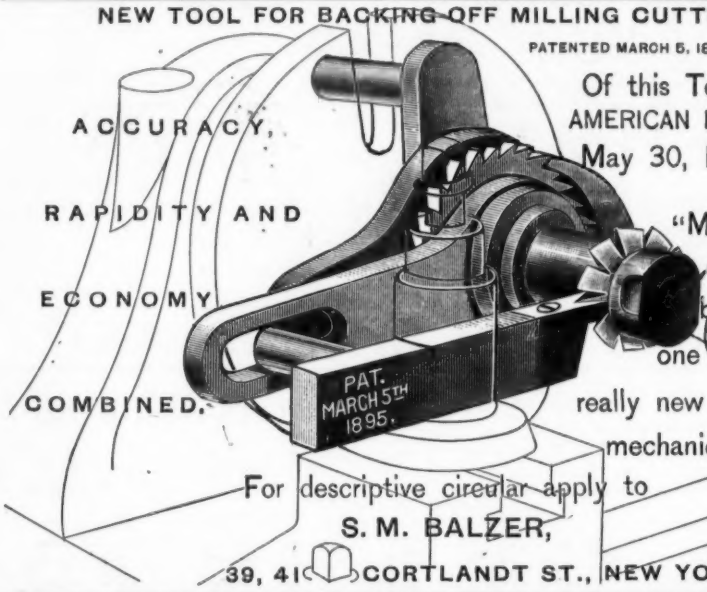

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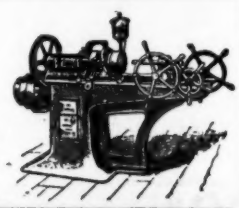

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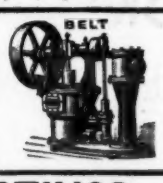

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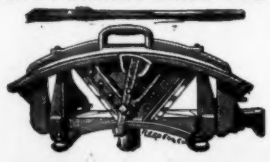

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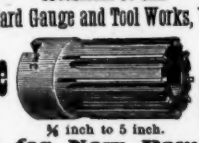

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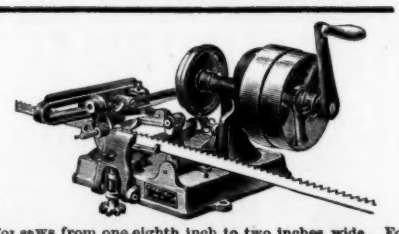

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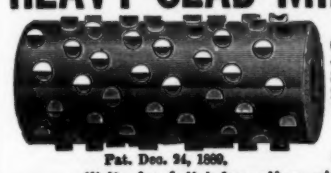

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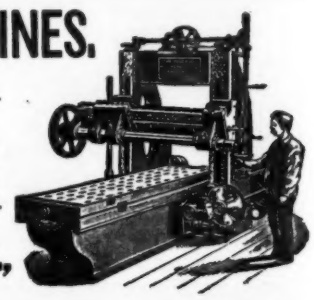

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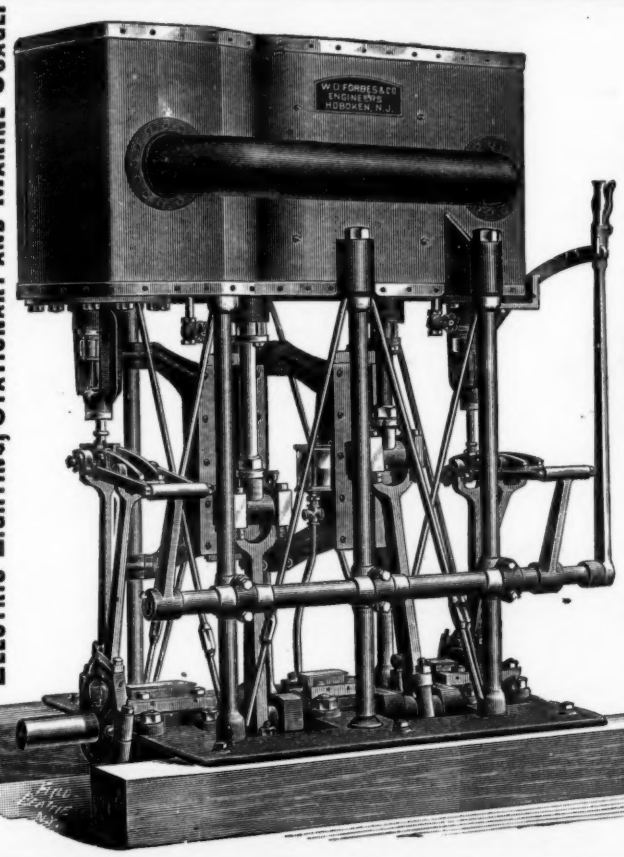

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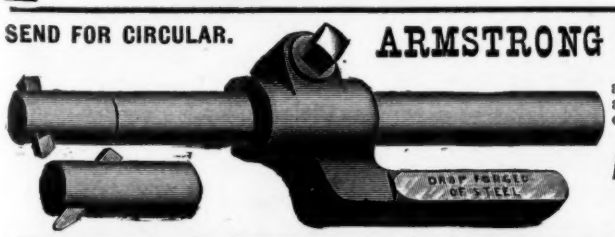

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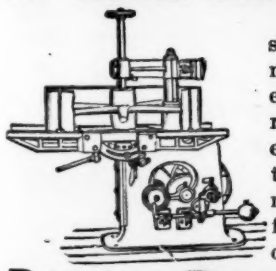

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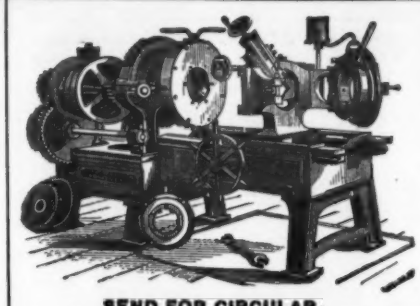

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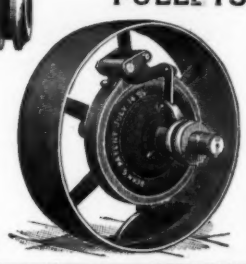

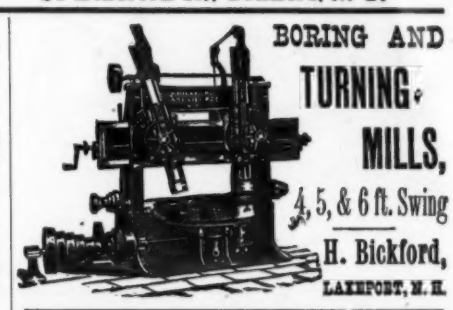

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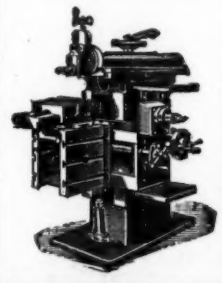

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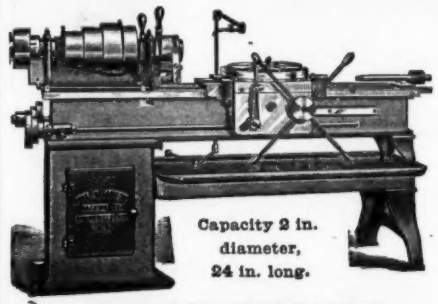

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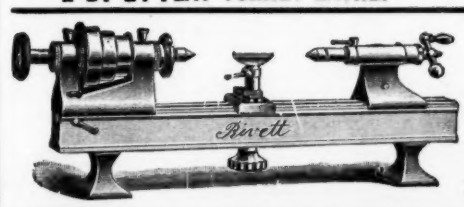

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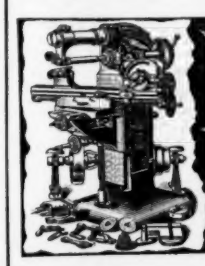

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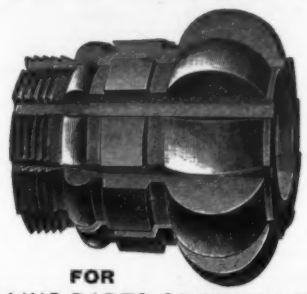

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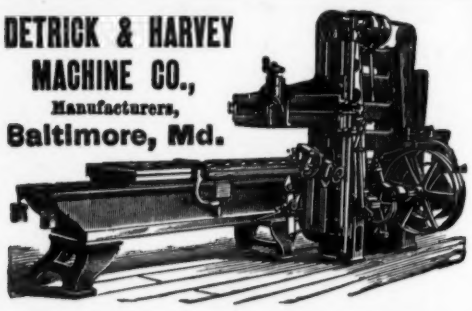

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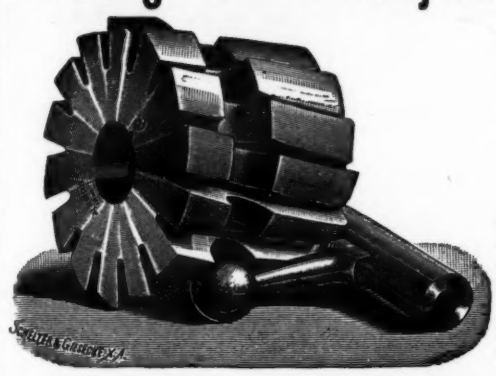

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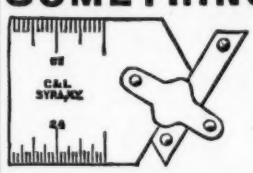

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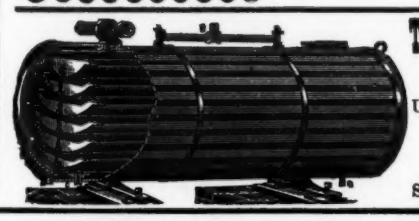

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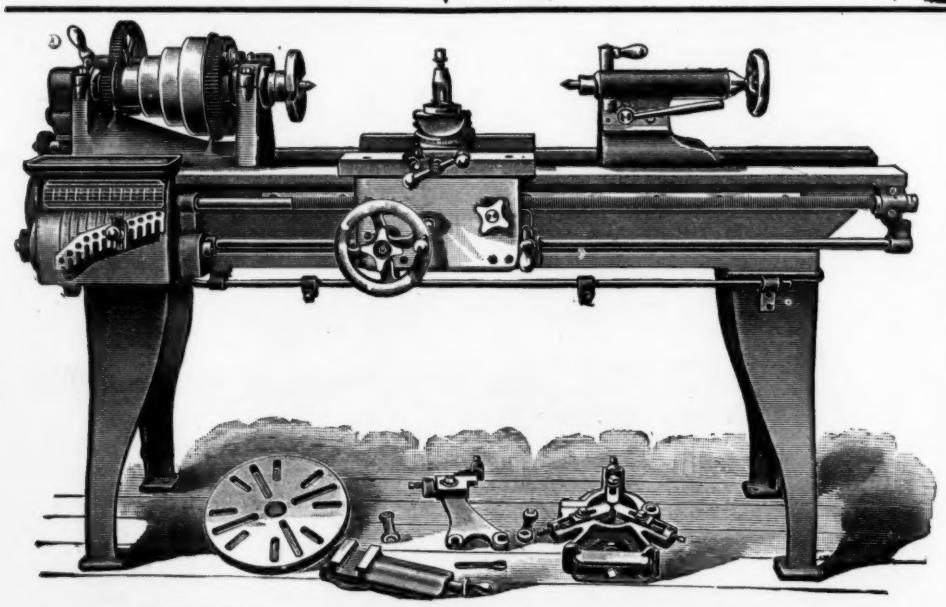

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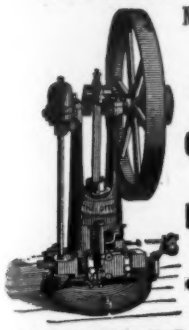

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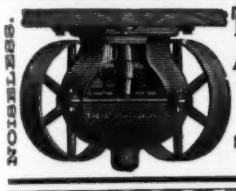

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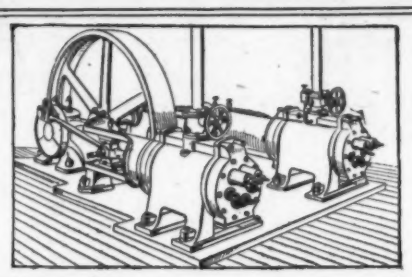

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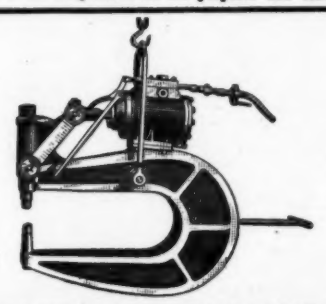

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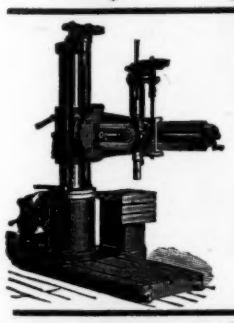

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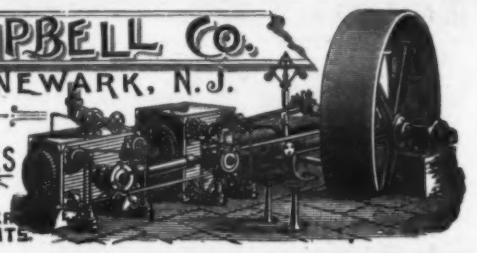

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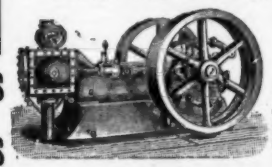

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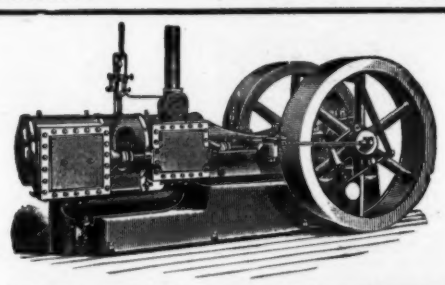

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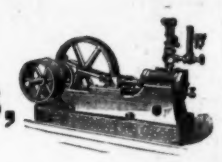

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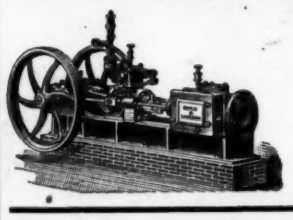

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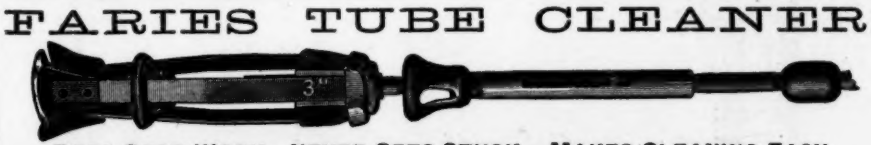

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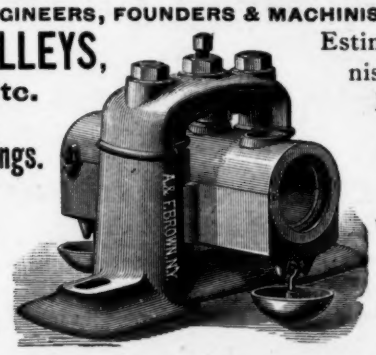

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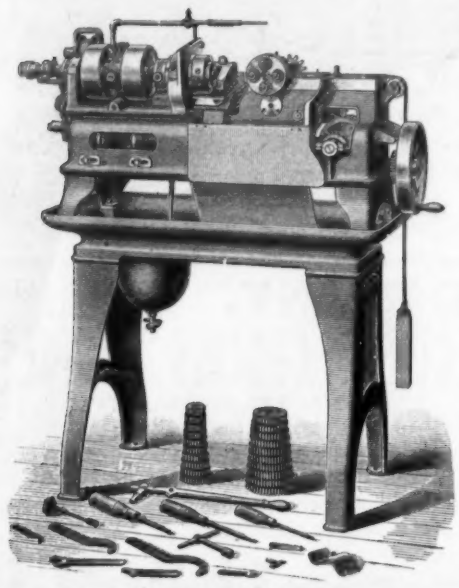

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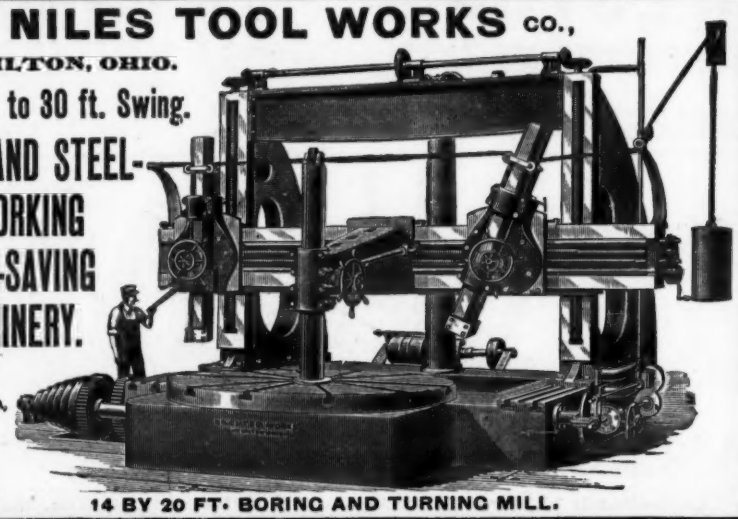

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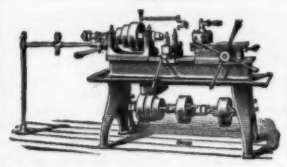

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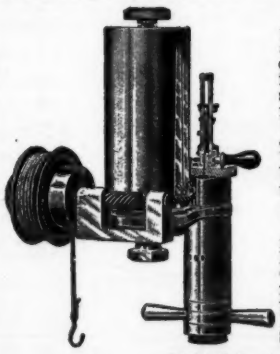

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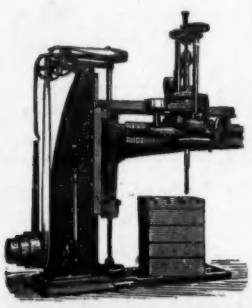

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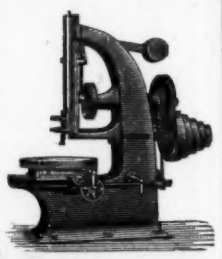

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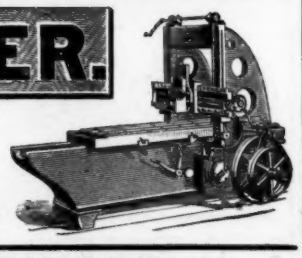

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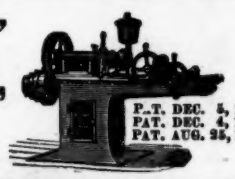

P. T. DEC. 5, 1882.
PAT. DEC. 4, 1883.
PAT. AUG. 25, 1885.

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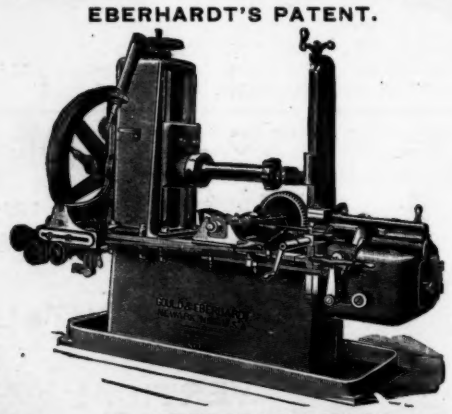

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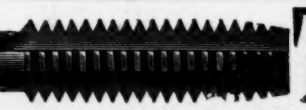

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